Informing the Process of the Collective-Efficacy-Mechanism-to-Action Model through Analysis of a Multilevel, Multisite Intervention:

The Children's Healthy Living Program

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By

Jean A. Butel

Dissertation Committee:

Claudio Nigg, Chairperson
Kathryn Braun
Rachel Novotny
James Davis
Carol Boushey

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ABSTRACT

Interventions to reduce health disparities should target organizations, communities, and policy, plus individuals and families. Community collective efficacy (CE), defined as social cohesion combined with willingness to act/intervene, has potential to affect health outcomes. Place-based relationships are central to CE, as social cohesion is built through social bonding, social bridging, and social leveraging. CE involves citizen empowerment and civic engagement, preparing citizens to act to address organizational, community, and policy issues. However, there is a lack of pathway clarity by which CE is strengthened in community interventions aiming for multilevel change.

In this dissertation, the Collective Efficacy Mechanism to Action Model (CE MAM) is proposed to fill this gap. The model is tested using Children's Healthy Living (CHL) program data, which aimed to prevent young child obesity through 19 activities in four areas: (1) assessing/strengthening school wellness policies and the community's physical environment; (2) partnering/advocating for environmental change; (3) promoting CHL messages; and (4) building capacity to promote six CHL behavioral objectives (increasing children's physical activity, fruit/vegetable consumption, water consumption, and sleep, and decreasing sugar-sweetened beverage consumption and recreational screen time). Intervention effect was tested through a cluster randomized controlled trial in Alaska, American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and Hawai'i, where nine communities received the intervention, and nine matched communities served as controls.

Chapters one, two, and three provide background. Chapter four presents results on CE intervention dose obtained across the nine communities, suggesting a critical CE dose for affecting community outcomes. Chapter five presents results from social network analyses in each intervention community, suggesting strong linkages between community groups, local schools, and large organizations are needed to affect change in children's behaviors. Chapter six explored strategies and barriers in intervention implementation across the nine communities, finding that multiple CE building blocks need to be strengthened simultaneously to affect change, and that time for tailoring the intervention to local conditions was a barrier.

Multilevel community interventions could use the CE MAM to develop, implement, and track interventions. The actualization of the CE MAM may prove beneficial in reducing health inequality and improving community outcomes.

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CHAPTER 1. INTRODUCTION

Background and Significance

Improving health outcomes in communities burdened with poor social determinants of health is a complex task and involves many factors. Achieving health equity, the highest level of health for all people, will require addressing the social, economic, and environmental disadvantages experienced in vulnerable communities (Department of Health and Human Services, 2016). In the United States (U.S.), safe neighborhoods, more education, greater social interactions, and good access to healthy foods are predictors of better health (Alder & Newman, 2002; Braveman, 2006; Walker, Keane & Burke, 2010). Unfortunately, these factors are commonly lacking and difficult to achieve for certain communities.

The tendency of research and policy makers to focus on individual solutions to community problems leads to a failure to address the broader social, physical, economic, and policy environments (Dougherty, 1993; Richards, Reid, & Watt, 2003). Interventions embracing an ecological perspective are more likely to be effective than interventions that only target the individual (Glanz & Bishop, 2010). The process of behavior change is multifaceted and requires addressing multiple factors at multiple levels (Glanz & Bishop, 2010).

Among the 2015 National Heart, Lung, and Blood Institute workgroup recommendations for implementing multilevel interventions were: *1) Include persons indigenous to the area or setting in all phases of the planning and implementation process. 2) Acknowledge the high level of heterogeneity in participant response to treatment by incorporating an adaptive intervention approach. Use empirical novel statistical tools to find the best tailoring variables for better characterizing patient's heterogeneity. 3) Consider secondary analysis questions regarding the relationship between dose across multiple settings (including synergistic effects) and study outcomes. 4) Use a clearly articulated conceptual model showing the relationships among major intervention components or a program planning model to guide the choice of the intervention components.* (National Heart, Lung, and Blood Institute, 2015). The challenges and promising approaches to implement these recommendations are described below.

1) Include persons indigenous to the area or setting in all phases of the planning and implementation process.

Challenges

To implement complex multilevel community interventions a "place-based" organizing framework involving collaboration of community-based partners has been recommended (Department of Health and Human Services, 2016), and development of community-based coalitions and networks have the potential to lead to better health outcomes (Gibbons & Weiss, 2012; Scanlon, Beich, et al., 2012).

However, the impact of community-based collaboratives on community health has been called into question (Kreuter, Lezin, & Young 2000). The lack of mechanisms to carry out planning and implementation, unrealistic health outcomes imposed by funders, and ways to demonstrate relationships between activities and outcomes have all been cited as potential reasons for not appreciating impact (Kreuter, Lezin, & Young 2000). Additionally, the lack of local support, leadership, or resources can create significant challenges in implementing complex interventions (Slater et al, 2005). The implementation of complex interventions that address health disparities, in a comprehensive manner, requires building collaborative capacity to take collective action (Kendall et al, 2012).

In addition, ensuring all partners have a say and take an active role in the process is deemed essential for building capacity for collaborative partnerships, and the lack of capacity of coalitions to engage in the process can contribute to "powerlessness" (Bess, Prilleltensky, Perkins, & Collins, 2009). Interventions impact evolving networks, change relationships, displace existing activities, and redistribute and transform resources (Hawe, Shiell, & Riley, 2009). Therefore, understanding the dynamic relationships involved with the implementation of community-based interventions is necessary.

Identified Approach

Studying the structural and community contributors of multilevel interventions provides an opportunity to develop scientific theory and methods (Trickett & Beehler, 2013). Social network analysis (SNA) is an approach to examine relationship patterns and investigates the underlying social structures and relationships (Maya-Jariego, Holgado, 2015). SNA focuses on relationships among groups of collaborating entities. SNA is presented as a graph with each participant in the collaboration termed an actor and depicted as a node in graph theory. Line

thickness between the nodes reflects the strength of the relationship. SNA has been used on differing levels from individuals, families, groups, organizations, to nations (Wasserman & Faust, 1994). Social analysts believe that "how" individuals and entities operate depends largely on how they are tied to larger social connections (Faust et al., 2015). SNA has been around for over 70 years and has been applied in different fields such as sociology, communication science, marketing, computer science, and mathematics (Wasserman & Faust, 1994). It provides a means to understand the relationships and social structures that are involved with the implementation of multilevel community-based interventions that are not easily recognized (Todd, Houston, & Suffrin, 2015) and looks at the influence of individuals, community organizations, and networks (Faust et al., 2015; Menger et al.,2015).

2) Acknowledge the high level of heterogeneity in participant response to treatment by incorporating an adaptive intervention approach. Use empirical novel statistical tools to find the best tailoring variables for better characterizing patient's heterogeneity.

Challenges

The need to culturally-adapt evidence-based interventions in the increasingly diverse American population has emerged in prominence over the last decade (Castro, Barrera, & Steiker, 2010). Several conferences and workgroups have convened to discuss how to approach and adapt evidence-based interventions to the specifics of new communities (Trickett &Beehler, 2013; National Heart Lung and Blood Institute, 2015). How interventions "fit" with the culture and still maintain the fidelity of evidence-based programs has been the focus of numerous studies (Castro, Barrera, & Steiker, 2010). Articles have looked at various techniques from "adaptation traffic lights" for program implementation (Tomioka et al, 2012) to guidance on overcoming barriers when approaching new communities (Nápoles, Santoyo-Olsson, & Stewart, 2013). However, there are few methods that assess strategies and barriers encountered while actualizing multilevel, complex community interventions (Richard et al, 2002; Trickett & Beehler, 2013). A meta-analysis conducted by Strange (2012) concluded that "this literature is characterized by limited reporting of theoretical, contextual, temporal, and implementation factors" (p. 20) and that theory, models, and interventions were not well-integrated.

Identified Approach

Researching multilevel interventions requires attention to the context of place and culture where the intervention is implemented, as well as to the interplay between the influences of the

social, political, and economic environment (Kothari et al, 2007). Multilevel interventions are likely to look different across communities due to differences in social networks, agencies, political context, and populations (Schensul, 2009). As of 2015, no SNA of health-focused interventions in low and middle income countries has been conducted (Perkins et al, 2015). There is a move in intervention science to accept case study designs and to systematically synthesize results from studies conducted across locations to draw inferences across location contexts (Kothari et al, 2007).

The use of cross-case analysis can shed light into the ways that complex interventions are implemented through the examination of detailed in-depth data that is rich in context (Creswell, 1998). In cross-case analysis each community is regarded as a case, and the method facilitates the comparison of commonalities and differences across these communities (Yin, 2003). This approach lends to increasing the understanding of how relationships may exist across cases allowing investigators to refine and develop concepts that can yield useful insights into the ways that multilevel interventions are implemented within particular communities and socio-political contexts (Ragin, 1997).

An example of cross-case analysis applied to a multilevel multisite intervention is the evaluation of the South Australian Obesity Prevention and Lifestyle (OPAL) initiative (Richards et al, 2014). This study used cross-case analysis methods to look at barriers to implementation fidelity in a multilevel multisite childhood obesity intervention. The study looked at intervention activities and determined if the activities were: implemented as planned; purposefully adapted to local contexts; or modified due to barriers (signaling a lack of intervention fidelity). Activities that were modified due to barriers underwent cross-case analysis to identify lack-of-fidelity themes. The themes were broken down into ecological themes and relational themes that allowed inferences to be made about implementation barriers across locations (Richards et al, 2014).

3) Consider secondary analysis questions regarding the relationship between dose across multiple settings (including synergistic effects) and study outcomes"

Challenges

What to implement, and what amount is needed, to affect change, in multilevel interventions is unclear. Few published results from community-targeted interventions have reported information on intervention dose or related it to health outcomes. A framework used in intervention research to estimate intervention dose is RE-AIM (Reach, Effectiveness, Adoption,

Implementation, and Maintenance). Reach is the intended target population; Effectiveness equates to efficacy; Adoption is the uptake of the intervention by target staff, settings, or institutions; Implementation is the consistency and adaptations made to the intervention; and Maintenance is the intervention effects in individuals and settings over time (Glasgow, Lichenstein, & Marcus, 2006). RE-AIM provides an evaluation framework to expand assessment of interventions beyond efficacy to multiple criteria to better identify the impact of health interventions (Glasgow, Lichenstein, & Marcus, 2006). However, across the literature, less attention has been paid to measuring intervention dose, and most attempts to focus on determining dose in individual-level behavior change interventions rather than in population-level behavior change interventions (Cerzo, Dasi, & Ruzi, 2013; Goode, et al, 2015).

Identified Approach

Cheadle (2012a) used RE-AIM to estimate population-level-intervention dose. The authors defined population dose as "the estimated community-level change in the desired outcome expected to result from a given community-change strategy" (p 74). In other words, it is the product of the reach of the activity into the target population and the expected effectiveness of the strategy on the target population. Cheadle et al (2012a) applied this population-dose model to Kaiser Permanente's Community Health Initiative to increase physical activity in middle-school students. Strategies were coded as having "low", "medium", or "high" effect strength, and the investigators found that communities with a "high dose" had more positive behavioral outcomes (Cheadle et al, 2012a). Thus, the use of RE-AIM protocols in the development of a dose calculation for multilevel interventions has potential (Lane et al, 2016).

4) Use a clearly articulated conceptual model showing the relationships among major intervention components, or a program planning model, to guide the choice of the intervention components.

Challenges

The main model used by multilevel interventions is the Social Ecological Model (SEM) (McLeroy, Bibeau, Steckler, & Glanz, 1988), with activities addressing the intrapersonal, interpersonal, organizations, community, and policy levels. The SEM is an ecological perspective that emphasizes multiple levels of influence. It helps frame the factors that influence behaviors and provides a guide to develop multilevel interventions and programs (Bronfenbrenner, 1979).

The SEM has often informed interventions, but "how" it has been applied and practiced in research is poorly documented (Glanz & Bishop, 2010). There has been a call to "design multilevel programs using systems and social/ecological models that attend to "connectedness" and integration across program components and levels" (Glasgow & Emmons, 2007, p. 427). Lessons learned from multilevel intervention research suggest a need for explaining interactions between the levels both theoretically and practically (Clauser, 2012).

Identified Approach

Interventions to address health outcomes by increasing CE have also been recommended and encouraged (Chou, 2012; Cohen et al., 2006; Kimbro et al., 2011). Per Bandura (1997), CE is the shared belief that actions by a group will influence the future they seek. Sampson (1997, p. 918) defines CE as "social cohesion among neighbors combined with their willingness to intervene on behalf of the common good," and there is evidence suggesting that community CE is a mediating factor in community health outcomes (Browning & Cagney, 2003; Frazini, Caughy, Spears, & Esquer, 2005). The concept refers to a social, community-level approach to addressing collective issues in communities (Bandura, 2000).

Translating research theory to action, all the while considering the unique socio-political components, has been a goal of public health research. The complexity of multilevel dynamic interventions that encourage involvement of community and require collaboration is articulated in the recommendations of the National Heart Lung and Blood Institute (NHLBI) working group. The challenges of including community members, considering culture, and grasping the dynamics of daily living in evidence-based interventions can be daunting and complicated. However, innovative adaptable approaches placed within a framework or planning model that resonates with researchers and community members is a way to bridge the gap in the literature and in communities. Collective efficacy is such a framework, and identifying ways to apply, measure, and evaluate it in a context of cross-case analysis of communities shows promise and is the focus of this dissertation.

Status of Knowledge Regarding CE

CE has been linked to better community-level health outcomes, health promoting behaviors, and school attendance (Azevedo et al., 2013; Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Halbert et al., 2014). Studies of neighborhood CE have shown that communities and neighborhoods with higher CE have lower prevalence of depression and risk-

taking behaviors, lower rates of morbidity and mortality, and lower neighborhood crime when compared to similar communities with low CE (Kimbro, Brooks-Gunn, & McLanahan, 2011; Sampson, Raudenbush, & Earls, 1997; Skrabski, Kopp, & Kawachi, 2004; Smith, Osgood, Caldwell, Hynes, & Perkins, 2013). In addition, neighborhoods with higher CE have lower prevalence of obesity (Cohen, Finch, Bower, & Sastry, 2006).

Multiple measures of CE have been developed (Israel et al, 1994; Perkins et al, 1990; Sampson, 1997) The most frequently cited tool is the neighorhood CE scale developed by Sampson (Figure 1.1). After demonstrating the reliability of this CE tool, Sampson (1997) and colleagues used it to examine the effect of CE on violence in low-income neighborhoods in Chicago. This foundational study found that "collective efficacy is an important construct that can be measured reliably at the neighborhood level by means of survey research strategies" (Sampson, 1997, p. 923). The scale has been used in other cross-sectional study designs to look at the affect of CE on obesity, the built environment, depression, resiliency, disease outbreaks, mordity and mortality, positive health behavior, risk-reduction behavior, smoking, and violence (Ahern & Galea, 2011; Cohen, Finch, Bower, & Sastry, 2006; Fong & Chang, 2011; Lowe et al, 2015; Karasek, Ahern, & Galea, 2012; Kimbro, Brooks-Gunn, & McLanahan, 2011; Skrabski, Kopp, & Kawachi, 2004; Smith, Osgood, Caldwell, Hynes, & Perkins, 2013; Ahern et al, 2009). A majority of these studies were conducted in the United States (Ahern & Galea, 2011; Cohen, Finch, Bower, & Sastry, 2006; Lowe et al, 2015; Karasek, Ahern, & Galea, 2012; Kimbro, Brooks-Gunn, & McLanahan, 2011; Skrabski, Kopp, & Kawachi, 2004; Smith, Osgood, Caldwell, Hynes, & Perkins, 2013; Ahern et al, 2009) with one conducted in Taiwan (Fong & Chang, 2011) and one in Hungry (Skrabski, Kopp, Kawachi, 2004). The NHBLI workgroup (2015) recommended the use of validated and reliable measures to assess the effectiveness of interventions. Sampson's neighborhood CE scale has potential to be a measure to gauge an intervention's affect to strengthen CE and how CE is associated with community health outcomes.

Bandura (2000) notes that although the focus is on strengthening CE at the community level, the application of CE is interwoven into individual, group, organizational, and policy interventions. Sampson's definition of CE as "social cohesion among neighbors, combined with their willingness to intervene on behalf of the common good" (1997. p.918) points to the need to involve the community on these multiple levels as well. The eight interventions aiming to

address health disparities by increasing collective CE have suggested that increased CE is associated with increased positive behavior, improvements in physical activity and obesity-related behaviors, and decreased risk-taking behavior (Azevedo et al., 2013; Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Halbert et al., 2014).

Sampson Collective Efficacy instrument (Sampson. Science 1997; 277, 918)

For each of the following, please tell me if it is very likely, likely, neither likely or unlikely, unlikely, or very unlikely that people in your neighborhood would act in the following manner. Just omit any question that is not applicable to your neighborhood.

		Very Likely (5)	Likely (4)	Neither likely or unlikely (3)	Unlikely (2)	Very unlikely (1)
1	If some children were spray-painting graffiti on a local building, how likely is it that your neighbors would do something?	❑	❑	❑	❑	❑
2	If there was a fight in front of your house and someone was being beaten up or threatened, how likely is it that your neighbors would break it up?	❑	❑	❑	❑	❑
3	If a child was showing disrespect to an adult how likely is it that people in your neighborhood would scold the child?	❑	❑	❑	❑	❑
4	Suppose that because of budget cuts, the fire station closest to your home was going to be closed down by the city. How likely is it that neighborhood residents would organize to try to do something to keep the fire station open?	❑	❑	❑	❑	❑
5	If a group of neighborhood children were skipping school and hanging out on a street corner, how likely is it that your neighbors would do something about it?	❑	❑	❑	❑	❑
6	If a well known neighbor was short of cash to start a business in the area, how likely is it that he or she would be able to borrow money from people in the neighborhood?	❑	❑	❑	❑	❑
7	How likely is it that you could choose to move from this neighborhood in the next five years?	❑	❑	❑	❑	❑

For each of these statements, please tell me whether you strongly agree, agree, neither agree not disagree, disagree, or strongly disagree.

		Strongly agree (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Strongly disagree (1)
8	People around here are willing to help their neighbors	❑	❑	❑	❑	❑
9	This is a close-knit neighborhood	❑	❑	❑	❑	❑
10	People in this neighborhood can be trusted	❑	❑	❑	❑	❑

Figure 1. 1. ***Neighborhood Collective Efficacy Scale***

Theorists propose that CE requires social capital (i.e., bonding, bridging, and leveraging), as well as empowerment and civic engagement (Collins, Neal, & Neal, 2014); these five

elements are known as the CE antecedent variables, but will be referred to here as CE building blocks. There has been some research looking at building social capital (and in particular its components of social bonding, social bridging, and social leveraging), and the relationship of social capital to increasing social cohesion and CE (Beck, Ohmer, & Warner, 2012; Collins, Neal, & Neal, 2014; Domínguez & Arford, 2010). However, operationalizing CE as a focus of change and a unit of measure in multilevel community-level interventions is underdeveloped. Strategies to increase CE have not been well described, and the approach and definition can be interpreted and applied in numerous ways (Samuel, Commodore-Mensah, & Himmelfarb, 2013).

A systematic literature review by Butel (Chapter 2) found a lack of conceptual clarity and operationalization of CE. This coincides with findings of a meta-review by Egan and associates (2008) who noted "the lack of consensus regarding the definitions and usage of [these] psychosocial concepts in the research literature (p. 239)." The review conducted by Leroux (2014) concluded that incorporating social relational constructs beyond the individual level was "dauntingly complex and inaccessible among researchers" (p. 8). Another of the literature gaps in operationalizing CE is how to implement CE building blocks into community activities. A better understanding of the strategies and barriers to implementing CE activities in communities will be informative and practical.

The review by Butel (2016) also found that (1) improvements in CE were linked to improved health outcomes; (2) intervention activities strengthening all five CE building blocks realized better health outcomes than interventions strengthening fewer than five (Table 1.1); and (3) interventions aiming to improve health through CE should intervene on multiple socio-ecological levels. The findings also pointed to substantial opportunities to better comprehend and implement a CE process to improve community outcomes.

Based on the literature, a model of the CE mechanism of action was developed (Butel & Braun, 2016) (Figure 1.2). The CE MAM shows that intervention activities--like hands-on training, leadership development, peer mentorship, community events, directed projects, and advocacy--can strengthen the five CE building blocks, which in turn improves overall CE (social cohesion and willingness to act), and health outcomes.

Table 1. 1. ***Intervention activities by CE Building Block (Butel & Braun, 2016)***

	Individual level activities								**Group level activities**						**Community level activities**			
CE Building Block	Formative Research	Communication/ skills workshons	Trainings	Train the Trainer	Research training	Reflection	Volunteering	Discussion	Community Project	Neighborhood Assessment	Self-help groups	Family to family connections	Train the trainer	Support organizations/ setting		Strengthening community norms	Engagement
Empowerment		✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓
Social Bonding		✓				✓	✓	✓			✓	✓				✓	
Social Leveraging	✓	✓	✓				✓					✓		✓			
Social Bridging	✓	✓				✓	✓	✓			✓						
Civic Engagement									✓								✓

What is not known about the CE MAM is the extent to which each of the building blocks needs to be addressed, the order or importance of the order of implementing the building blocks, and what group relationships and strategies are needed to implement community activities.

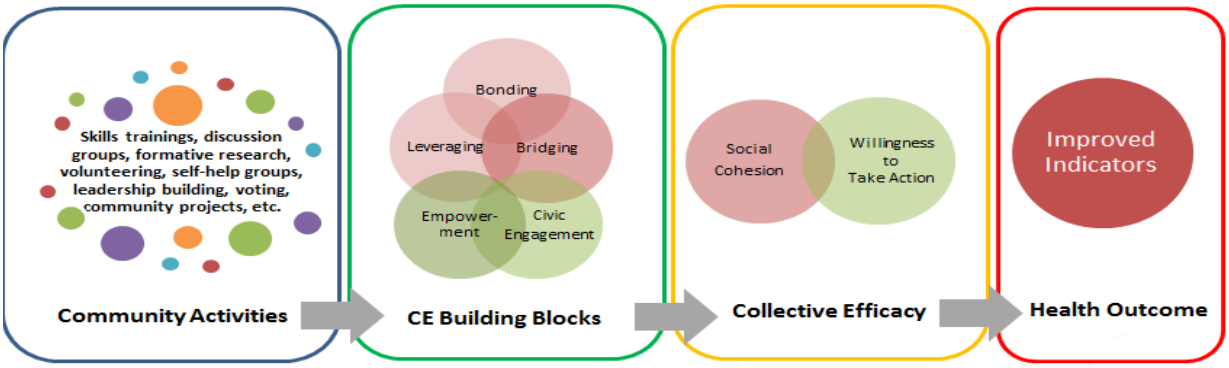


Figure 1.2. ***Collective Efficacy mechanism of action model (CE MAM)***

To examine these unknowns, this dissertation applied a cross-case analysis approach to the data associated with CHL. As noted above, cross-case analysis is a method for mining case studies so the knowledge can be utilized for a broader purpose (Ayre, Kavanaugh, & Knafl,

2003). Cross-case studies have been utilized to build upon theory and can be used to either "(a) predict similar results (a literal replication) or (b) predict contrasting results but for predictable reasons (a theoretical replication)" (Yin, 2003, p. 47). This dissertation applied cross-case analysis methods to facilitate an understanding of the CE MAM using real-life cases from a complex multilevel multisite intervention.

The Children's Healthy Living Program

Childhood obesity is a serious public health challenge. It is an issue internationally (World Health Organization, 2016), and in the United States where childhood obesity rates have more than doubled in the last 30 years (Ogden et al., 2014), and in the Pacific (Oceanic) Islands (Novotny et al., 2015). This complex issue has multiple causes (Sahoo et al., 2015). Environment, culture, family, individual factors, as well as policies have an effect on behaviors (such as high recreational screen time) and are all associated with childhood obesity (Sahoo et al, 2015).

To address the growing prevalence of obesity in the United States Affiliated Pacific (USAP) region, the (USDA) Agriculture and Food Research Initiative funded the CHL program for five years (2011-2016) to develop and test a community-driven multilevel multijurisdiction intervention. The CHL intervention's effect was tested through a community-randomized controlled trial (CRCT) in five jurisdictions, where nine communities received the intervention, and nine matched communities served as delayed-intervention controls (Wilkens et al, 2013). Another nine communities served as temporal controls. The CRCT aimed to evaluate the intervention's impact on anthropometric indicators including body mass index (BMI) and waist circumference, acanthosis nigricans, and six behavioral objectives among children age 2-8 years. Behavioral objectives included increasing fruit and vegetable intake, water consumption, physical activity, and sleep duration; and reducing recreational screen time and sugar-sweetened beverage consumption (Wilkens et al, 2013). The intervention had a significant positive effect on decreasing acanthosis nigricans, waist circumference, overweight status, and recreational screen time (Novotny, 2017).

Based at the University of Hawai‘i at Mānoa, the CHL coordinating center subcontracted with four other Land Grant institutions in the USAP (the University of Alaska at Fairbanks, American Samoa Community College, the Northern Marianas College, and the University of Guam) to carry out the objectives of CHL in their respective jurisdictions. As recommended by

the Analysis Grid for Environments Linked to Obesity (ANGELO) framework, the team designed the multilevel intervention by merging community input and evidence-based strategies identified in the literature (Nigg et al, 2016; Braun et al, 2014; Fialkowski et al, 2014). CHL sought to identify, and build on, what was working in communities by engaging community partners and members in ways that were sensitive to their culture, as well as place the health and wellbeing of young children at the forefront of community decisions and actions. In essence, the CHL intervention was a community-based collaboration that promoted CE among community members, groups, and CHL implementing staff.

The CHL intervention consisted of 19 activities of four types: (1) assessing (and strengthening) school wellness policies and the community's physical environment; (2) partnering and advocating for environmental change; (3) promoting CHL messages; and (4) building capacity to promote the six CHL behavioral objectives. Although not specifically designed to address CE, Table 1.2 demonstrates how the CHL intervention activities were similar to activities identified in the literature review of CE interventions (Butel & Braun, 2016).

Table 1. 2. ***Relationship between CHL Intervention Activities to CE Building Activities***

CHL Intervention Activity	Identified CE Building Activity
CCF1. Assess Pre-School Policy and Community Environment related to the six CHL behaviors*	
1a. Assess existence and quality of preschool wellness policy	Formative Research Neighborhood Assessment Research training
1b. Assess community physical environment for policy change	Formative Research Neighborhood Assessment Research training
CCF2. Environmental Change	
2a. Work with organizations/coalitions to advocate for:	
2ai Better access to parks that are safe and inviting	Support organizations/settings Community Project Community Engagement
2aii Better access to clean water	Support organizations/settings Community Engagement
2aiii Safer environments for walking, biking, etc. (e.g., bike lanes/racks, sidewalks, greenways)	Support organizations/settings Community Project Community Engagement
2aiv Better food placement/availability	Support organizations/settings

CHL Intervention Activity	Identified CE Building Activity
2av Gardens and hydroponics	Community Engagement Support organizations/settings Community Project Community Engagement
2b Partner with existing entities to purchase or obtain sponsorship for:	
2bi Water in the preschools and childcare centers	Support organizations/settings Community Engagement
2bii Gardening supplies for preschool kids	Support organizations/settings Community Engagement
2biii Sports equipment for preschool kids	Support organizations/settings Community Engagement
2biv Campaigns and messages	Strengthening community norms Community Engagement
CCF3. Promote the CHL Message	
3a Support Role Models to deliver CHL messages in various ways (using the CHL role model curriculum as a guide)	Volunteering Discussion Community Engagement
3b Enhance exiting social marketing campaigns in the intervention communities, and/or develop low-cost local social marking campaigns related to the 6 CHL behaviors	Strengthening community norms Community Engagement
3c Advertise CHL or other activities that promote six CHL target behaviors*	Strengthening community norms Community Engagement
CCF4. Train the Trainers	
4a Train individuals to promote gardening in preschools and communities	Skills workshops Train the Trainer Volunteering Community Engagement Community Project
4b Train individuals to lead interactive, hands-on sessions to promote the six CHL behaviors*	Skills workshops Train the Trainer Volunteering Community Engagement
4c Train individuals to organize and lead family-based activities that support the 6 CHL behaviors (park clean-ups, hikes, cooking sessions, etc.)	Skills workshops Train the Trainer Volunteering Community Engagement Family-to-Family Connections
4d Provide technical assistance to preschool and childcare staff on wellness policies	Skills workshops Train the Trainer

CHL Intervention Activity	Identified CE Building Activity
4e Train childcare providers and preschool teachers in curricula related to six CHL behaviors*	Communication training Support organizations Skills workshops Train the Trainer
4f Train role models (community champions, role celebrities, role models) to promote and provide curricula related to the six CHL behaviors*	Communication training Support organizations Communication/Skills workshops Train the Trainer Volunteering Community Engagement Family-to-Family Connections

* Six CHL behaviors: Increase water consumption, fruit and vegetable consumption, physical activity, and sleep; Decrease screen time and sugar sweetened beverage consumption

The CHL program provided a research opportunity to examine the process (i.e., extent, order, relationships, strategies and adaptation) of implementing activities that build CE. Over the two-year intervention period, each of the nine CHL intervention communities submitted monthly process reports to the CHL coordinating center. These reports allowed the coordinating center to monitor intervention activities, identify strengths and areas for improvement, leverage ideas for use in other communities, and track intervention progress. Using data from the monthly intervention process reports, CHL intervention dose was calculated as the number of activities x relative intervention effectiveness (0.33 for low to 1.00 for high) x ratio of the number of participants to the intended number of participants. Intervention dose was calculated for each community over the two-year intervention. Preliminary testing of the dose formula found a direct inverse relationship between community intervention dose and recreational screen time i.e., the higher the dose, the greater the decrease in reported screen time among young children (see Chapter 3).

The use of secondary data analysis to examine questions regarding the relationship between dose across multiple settings (including synergistic effects) to health outcomes has been recommended (NHLBI, 2015). In alignment with these recommendations, this dissertation was a secondary data analysis of the CHL intervention, using cross-case analysis techniques, with each intervention community designated as a case. The intervention process records, along with prior dose calculation efforts, were the foundation for the review and assessment of applied activities. This dissertation research provided an opportunity to show how CE activities were applied and

practiced in the CHL intervention in order to further develop and understand the mechanisms of the CE MAM. This research helps fill gaps in the CE literature on the lack of conceptual clarity and operationalization of CE.

Purpose of Dissertation

The purpose of this dissertation was to operationalize the CE MAM to provide a process to guide multilevel and CE community interventions by identification of CE building block activities in the CHL intervention. The rationale for this research was that strengthening CE improves local skills and capacity to initiate and sustain community change. This dissertation assumed the best method to understand how to strengthen CE could be determined by cross case analysis of multilevel intervention implementation. The documentation from the nine CHL intervention communities provided an excellent dataset for this analysis.

This dissertation strove to answer the following research questions: 1a. What was the CE dose and the dose of the five CE building blocks in the CHL intervention? 1b. Did the CE dose and the dose of the five CE building blocks, in the CHL intervention, correlate with change in screen time? 1c. Was there an order to the CE building block implementation? 2) What was the density and pattern of community networks throughout the CHL intervention? 3) What supported and hindered intervention success in CHL communities?

Conceptual Framework

As illustrated in Figure 1, for CE to contribute to the improvement of community health indicators, a process to increase CE needs to occur (Collins et al., 2014; Domínguez & Arford, 2010). Research suggests that social cohesion and willingness to act/intervene (key components of CE) can be strengthened by building social capital in communities (Collins et al., 2014). Thus, increasing social capital is a critical step in the process to increase CE, which can then improve health outcomes.

Social capital consists of the amount and quality of social networks between people with similar behavioral norms that allows for mutually beneficial cooperation. Social networks can be "reciprocated exchanges that promote collective efficacy or trust and cohesion among residents combined with expectations for informal social control related action" (Browning, Feinberg & Dietz, 2004 p. 504). These can be categorized as low frequency exchanges or high frequency exchanges. Social networks may provide social capital to communities, creating a capacity for social action that would not be available without a social network (Robbins, 2016). These

categories of social networks can be found in the social capital sub-concepts of social bonding, social bridging, and social leveraging (Browning, Feinberg & Dietz, 2004; Domínguez & Arford, 2010).

Looking further at the sub-concepts of social capital, at the individual and group level, social bonding can be defined as self-efficacy and self-esteem in peer groups (Domínguez & Arford, 2010). According to Larson (2004), social bonding at the neighborhood/community level, requires social trust and association. Per Larson (2004), "social trust refers to passive emotional sentiments and association refers to the behaviors that produce familiarity, such as informal socializing or lending a tool or providing assistance to a household" (p. 65). Social bonding creates closer ties between individuals in a group. Neighborhoods and communities with high social bonding are more likely than those with low social bonding to form social bridges with entities outside of their own communities (Hamidreza Babaei, 2012).

Social bridging consists of more distant ties to other groups such as loose friendships and co-workers. This concept is inclusive of other races, ethnicities, and other cultural dividers (Hamidreza Babaei, 2012) and based on generalized trust in nature. Social bridging brings in more resources to individuals and groups, connections, and opportunities (Domínguez & Arford, 2010; Hamidreza Babaei, 2012). By reaching out to other groups, social bridging is more akin to "getting ahead," whereas social bonding is more like "getting by" (Putnam, 2002). For example, with social bridging there are more links to programs and economic opportunities, whereas with social bonding the links to programs and economic opportunities are limited to those within the group. The redundancy of programs and resources between the groups, as well as lack of power in poor communities limits the ability of social bridging to expand opportunities (Hamidreza Babaei, 2012).

Social leveraging is the linking of community to people and/or groups in positions of authority and power (Woolcock, 2001). The linking to groups outside the community, such as government institutions, policy makers, businesses, and funders, can provide key resources to develop capacity and resources in the community (Hamidreza Babaei, 2012).

All three aspects of social capital (social bonding, social bridging, and social leveraging) affect community empowerment. Community Empowerment refers to enhancing the capacity of communities to make choices and transform the choices into desired outcomes (Alsop & Heinsohn, 2005). Studies have shown that bonding, bridging, and leveraging are needed for

empowerment. (Cramb, 2006; Harknett, 2006; Gerwitz, et al. 2005; Henly, Danziger, & Offer, 2005; Lin, 2001). An example of empowering communities is increasing their communication skills, which enhances the ability to intervene, which impacts CE (Kleinhans & Bolt, 2014).

Engagement within a community can take the form of volunteering and/or civic engagement. Civic engagement is defined as "individual activities of a democratic, political, and/or civic nature with the intent of addressing an issue of public concern" (Collins et al., 2014, p. 329). Civic engagement has been linked to CE, and those communities whose members are more civically engaged report higher levels of CE. Collins (2014) found that civic engagement is partially mediated by social capital, in particular social bonding. As depicted in Figure 1.2, the combination of social capital (comprised of social bonding, social bridging, and social leveraging), empowerment, and civic engagement are antecedents (i.e., building blocks) to CE and its components of social cohesion and the willingness to act/intervene (Collins et al, 2014; Dominguez & Arford, 2010; Babaei, 2012). Due to differences across communities, the amount of social capital already present needs to be determined and considered when tailoring interventions to improve CE.

Social capital is found across individuals, groups, organizations, and policy makers. The multilevel interaction of this construct leads to a multitude of ways to develop CE and has led to a variety of ways in which researchers have selected and operationalized indicators of CE (Rajaratnam, Burke, & O'Campo, 2006). The CE MAM conceptual model links intervention activities to CE building blocks to connect and integrate activities across the multiple levels.

Dissertation Conceptual Model

The three research questions presented in this dissertation have been framed using the CE MAM (Figure 1.3). The CE process provides a conceptual model that demonstrates how the research questions will further clarify and operationalize the CE mechanism of action model.

Chapters two and three describe preliminary studies that provide the basis for this dissertation. In Chapter 2, findings from a systematic literature review on interventions that aimed to improve health outcomes by strengthening CE are reported, and a manuscript based on this chapter has been submitted for publication with permission of the dissertation committee. In Chapter 3, methods developed by CHL to estimate intervention dose are presented, along with finding showing a positive correlation between intervention dose and child-level outcomes. A manuscript based on this chapter also has been submitted for publication with permission of the

dissertation committee. Both chapters present information that is foundational to understanding subsequent chapters, which describe investigations undertaken as part of this dissertation to further operationalize the CE MAM.

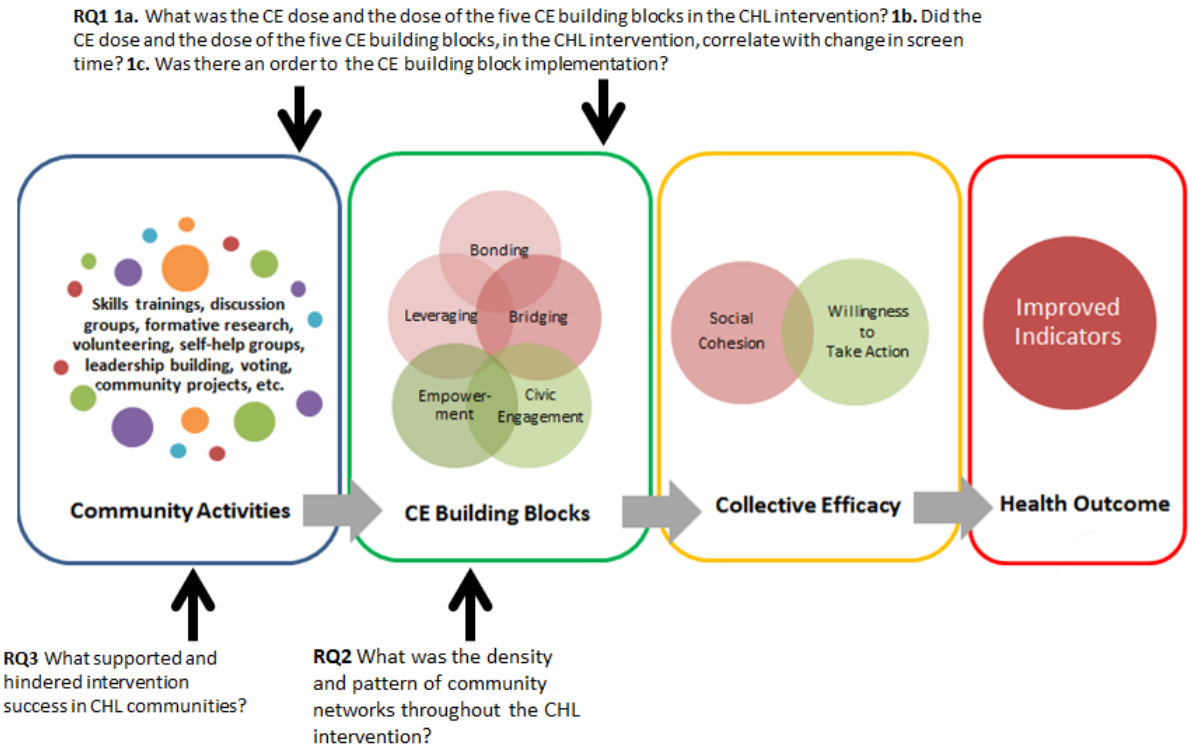


Figure 1. 3. ***Collective Efficacy Mechanisms to Action Conceptual Model***

Presented in Chapters 4, 5, and 6 are the methods and findings for my three dissertation questions. Chapter 4 estimates another dose, CE dose, which is then used to examine correlations between overall CE dose and change in screen time, correlation of the dose of the five CE building blocks and change in screen time, and the order of CE building block implementation (all of which are examined in that study). Chapter 5 investigates the social networks present in the CHL intervention and how they differed in high – and low-CE-dose communities. Chapter 6 identifies barriers and supports in the CHL intervention and how they differed in high – and low –CE-dose communities. Finally, Chapter 7 provides a summary of the main findings from the dissertation, recommendations for the application of the CE MAM, and future research needed.

CHAPTER 2: THE ROLE OF COLLECTIVE EFFICACY IN REDUCING HEALTH DISPARITIES: A SYSTEMATIC REVIEW

Abstract

Many improvements in health equity are spearheaded by community collaborations working to change policy and social norms. But how can collective efficacy (CE), defined as the willingness and ability of a group to work towards a common good, be increased? Eight articles reporting on interventions aiming to reduce health disparities by improving CE were found for this systematic literature review. All studies showed improvements in CE and most found reduction in disparities, but operationalization of CE varied. Findings support a model of how CE can address health disparities, which can guide standardization of CE interventions and measures.

Key words: collective efficacy, health disparity, systematic review, assessment tools

Note: This Chapter has been submitted for publication to *the Journal of Family and Community Health.*

Background

Achieving health equity, the highest level of health for all people, requires addressing the social, economic, and environmental disadvantages experienced in vulnerable communities (De Backer, 2003). Societal-level action is needed to make the changes in law, organizational policy, and social systems required to reduce community health disparities. Facilitating multilevel change requires collaboration, broadly defined as the working together of multiple individuals and/or organizations to accomplish some form of systems change (De Backer, 2003; Durlak & DuPre, 2008; Feinberg, Greenberg, & Osgood, 2004; Browning, Burrington, Leventhal, & Brooks-Gunn, 2008; Franzini, Caughy, Spears, & Esquer, 2005; Brown, Feinberg, & Greenberg, 2012).

Investigators have shown interest in measuring collaboration (or coalition function) with a goal of learning how to increase the collective efficacy (CE) of the collaboration (Brown, Feinberg, & Greenberg, 2012; Zakocs & Guckenburg, 2007). As self-efficacy is the belief in one's ability to act to produced desired results, CE is the shared belief that actions by a group will influence the future they seek (Feinberg, Greenberg, & Osgood, 2004; Browning, Burrington, Leventhal, & Brooks-Gunn, 2008). Key components of collective efficacy are social cohesion and a willingness to act/intervene (Browning, Burrington, Leventhal, & Brooks-Gunn, 2008).

The study of neighborhood CE has its roots in sociology and crime (Bandura, 1997; Sampson, Raudenbush, & Earls, 1997), and other studies have shown a strong link between low CE and high neighborhood crime rates (Sampson, Raudenbush, & Earls, 1997). Research also suggests that communities and neighborhoods with higher CE have lower prevalence of obesity, depression, and risk-taking behaviors and lower rates of morbidity and mortality when compared to similar communities with low CE (Cohen, Finch, Bower, & Sastry, 2006; Kimbro, Brooks-Gunn, & McLanahan, 2011; Skrabski, Kopp, & Kawachi, 2004; Smith, Osgood, Caldwell, Hynes, & Perkins, 2013). CE also has been linked to better community-level health outcomes, health promoting behaviors, and school attendance (Azevedo et al., 2013; Sampson, 2003; Halbert et al., 2014). In addition to neighborhoods, the concept has been analyzed for diverse social systems, including educational systems (Bandura, 1997), business organizations (Earley, 1994), and athletic teams (Carron, 1984).

Interventions to address health disparities by increasing community CE have been recommended and encouraged (Kimbro, Brooks-Gunn, & McLanahan, 2011; Chou, 2012). Yet operationalizing the construct as a focus of change and a unit of measure in intervention research is difficult, and strategies to increase CE have not been well described (Samuel, Commodore-Mensah, & Himmelfarb, 2013).

There is research suggesting that building social capital (which includes social bonding, social bridging, and social leveraging) can increase social cohesion and willingness to act/intervene, which are key components of CE (Beck, Ohmer, & Warner, 2012; Collins, Neal, & Neal, 2014; Domínguez & Arford, 2010). Research also suggests that empowerment (the capacity of communities to make choices and transform choices into desired outcomes) is a factor in the ability to intervene, which impacts CE (Alsop & Heinsohn, 2005; Kleinhans & Bolt, 2013). Civic engagement has also been linked to collective efficacy, as those who are more civically engaged report higher levels of CE (Collins, Neal, & Neal, 2014). Intervention activities such as education, skills training, and discussion groups, along with involving group members in formative research, community projects, volunteering, and advocacy, can build social capital, civic engagement, and feelings of empowerment (Tomas, McGarty, & Mavor, 2009).

However, the "building blocks" of CE are differentially studied and operationalized across investigators (Rajaratnam, Burke, & O'Campo, 2006). Literature reviews have looked at CE as: a component of psychosocial risk factors affecting community health (Egan, Tannahill, Petticrew, & Thomas, 2008); social networks and social capital in obesity-related interventions (Leroux, Moore, & Dube, 2013); and social network mechanisms (including CE) in improving chronic disease management (Vassilev, Rogers, Kennedy, & Koetsenruijter, 2014). However, no previous literature reviews have found interventions that focused on or aimed to reduce community health disparities by first improving CE.

Thus, this systematic literature review addresses three questions. In interventions aiming to increase CE, what intervention activities were provided to affect necessary CE building blocks (i.e., social bonding, bridging, leveraging, empowerment, and engagement)? How were changes in collective efficacy measured? Were improvements in CE linked to reduced community health disparities? Answering these questions will inform measurement methods and intervention approaches to positively impact CE.

Methods

A systematic literature review was conducted to identify articles about community-level interventions aiming to reduce a community health disparity by first improving CE. Community was defined as a group of people residing in a set geographical location, rather than a sports or educational team.

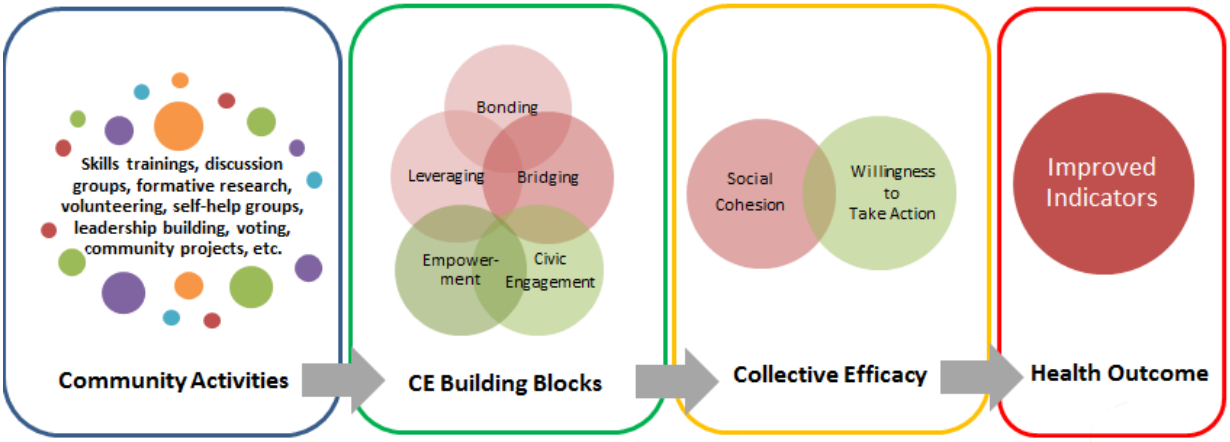
A Boolean search strategy was used, and PubMed, PsycInfo, ERIC, Cochrane, CINAHL, and Academic Search Complete databases were searched in January 2016 and again in July 2017 using combinations of the terms "collective efficacy" AND "intervention" OR "program evaluation" AND "communit*" OR "neighborhood*" OR "group*". Two authors (JB, KLB) reviewed the articles for eligibility. For each study, one author extracted and assessed the data (JB), while the other reviewer verified the accuracy (KLB).

Peer-reviewed articles were sought that reported: (1) intervention activities to increase collective efficacy; (2) a quantitative measure of collective efficacy; and (3) a measure of a health disparity. After duplicate articles were removed, the titles and abstracts were reviewed and excluded based on these criteria: *wrong topic* (the article was unrelated to CE; *wrong population* (the target population was a sports team, teachers' group, business team, or other group rather than a community); *no intervention* (the article focused on CE theory rather than activities to increase CE or reported on epidemiological studies using CE as a variable); *no measure* (CE was not measured); *wrong language*, (the article was written in a language other than English); and *no results* (the intervention addressed CE but did not report any results). The remaining articles were read in full, and the exclusion criteria were reapplied.

Abstracted information included: (1) whether or not formative research was used to develop the intervention, (2) the community members targeted, (3) the theory or model cited in the article, (4) the CE strategies and intervention activities, (5) the CE measure and results, and (6) the health issue measures and results. The community members targeted were categorized by age and sex.

Based on this review of the literature (Alsop & Heinsohn, 2005; Cramb, 2006; Collins, Neal, & Neal, 2014; Hamidreza Babaei, 2012; Harknett, 2006; Gerwitz, et al. 2005; Henly, Danziger, & Offer, 2005; Kleinhans & Bolt, 2014; Lin, 2001; Woolcock, 2005), a "mechanism of action" model was postulated to show how social capital (social bonding, social bridging, social leveraging), empowerment, and civic engagement can increase a group's social cohesion

and willingness to act, which can increase its CE, which can lead to improved health outcomes and reductions in health disparities (Figure 2.1). Intervention activities (e.g., skills building, discussion groups, community projects), were categorized by level of the targeted audience (individual, group, community) and by the building blocks of CE (social capital, empowerment, civic engagement) they addressed.



Bonding – Social bonding trust and association between neighbors and community partners (Dominguez & Alford, 2010)
Bridging – Social bridging consists of more distant ties to other groups (Dominguez & Alford, 2010)
Leveraging – Social leveraging linking of community to people and/or groups in positions of authority and power (Dominguez & Alford, 2010)
Empowerment – Enhances community capacity to transform choices into desired outcomes (Klienhans & Bolt, 2005)
Civic Engagement – Activities of a democratic political, and/or civic nature with the intent of addressing an issue of public concern (Collins, Neal, & Neal, 2014)

Figure 2. 1. ***Collective Efficacy Mechanisms to Action Model***

The quality of each included study was measured using the six criteria established by Megens and Harris (1998): (1) inclusion/exclusion criteria articulated, (2) program well described, (3) reliable measures used, (4) valid measures used, (5) assessors blinded, and (6) attrition tracked and revealed. For each criterion addressed in the study, a point was given, for a maximum of six points. For reliability, however, a point was given only if there was a citation of an established collective efficacy scale and/or stated a Cronbach's alpha score of greater than 0.70. Validity of the outcome measure was determined by comparing stated health outcome to the health items measured. To evaluate study rigor, study design also was considered, i.e., randomized controlled trial, quasi-experimental design, or non-experimental design.

Results

The search yielded 470 articles and 264 duplicates were removed. Two more articles were identified by citation chasing. Applying exclusion criteria resulted in eight articles (Figure 2.2).

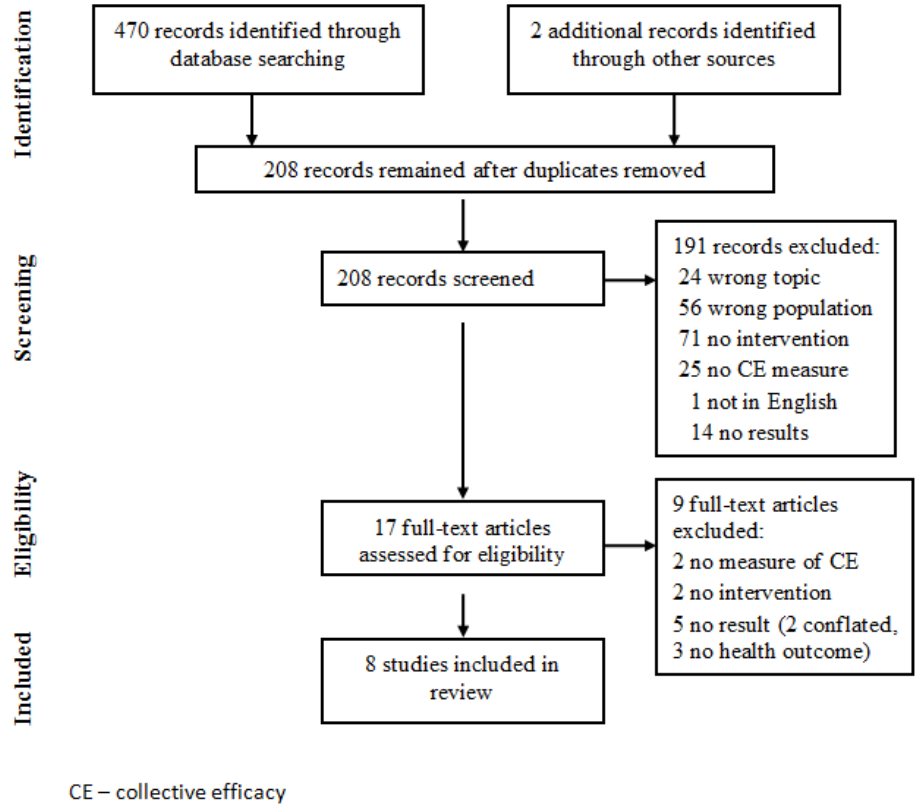


Figure 2. 2. ***Systematic Review Flow Chart (Moher, Liberati, Tetzlaff, & Altman, 2010)***

Study authors, locations, and targets are shown in Table 2.1. All of the studies were located in communities with health disparities. Of the eight articles, three reported on studies targeting youth (Berg, Coman, & Schensul, 2009; Carlson, Brennan, & Earls, 2012; Posner, Kayastha, Davis, Limoges, O'Donnell, & Yue, 2009), three targeted adults (Guha et al., 2012; O'Conner, 2013; Kuhlmann, Galavotti, Hastings, Narayanan, & Saggurti, 2014), one targeted families (Knox, Guerra, & Williams, 2011), and one targeted communities in a service area (McDonell, Ben-Arieh, & Melton, 2015). The health outcome of interest varied across articles. Of the three studies targeting youth, one looked at risk-taking behaviors (alcohol use, marijuana use, and sexual partners) of 87 urban youth in Connecticut (Berg, Coman, & Schensul, 2009), another looked at HIV awareness and prevention, and menstrual restrictions in 504 female

students in Nepal (Posner, Kayastha, Davis, Limoges, O'Donnell, & Yue, 2009), and the third asked 60 adults in one community about problems of youth in their neighborhood in Tanzania (Carlson, Brennan, & Earls, 2012). Condom use was measured in two (n=400 and n=1,986) of the adult studies (both in India) (Guha et al., 2012; Kuhlmann, Galavotti, Hastings, Narayanan, & Saggurti, 2014). Another study measured neighborhood participation in social action of adults (n= 28) in Southern California (O'Conner, 2013). Child aggression was measured by adult participants (n=282) in the family-focused study (Knox, Guerra, Williams, & Toro, 2011). The community-level intervention measured child abuse in South Carolina in two waves 3 years apart—in 2004 (n=229) and in 2007 (n=326) (McDonell, Ben-Arieh, & Melton, 2015).

Table 2. 1. ***Overview of studies***

Author	Number of participants	Population surveyed	Population receiving intervention activities	Location	Health Outcome of Interest
(Berg, Coman, & Schensul, 2009)	87	Youth (in program)	Youth (age 14-17, urban, predominately Caribbean and African American & Latino)	United States	alcohol marijuana sexual partners
(Carlson, Brennan, & Earls, 2012)	60	Adults (in community)	Youth (age 9 -14, residing in Moshi Urban district in the Kilimanjro Region)	Tanzania	Neighborhood problems
Posner, Kayastha, Davis, Limoges, O'Donnell, & Yue, 2009)	504	Youth (in program)	Youth (females, aged 11-24 from all castes)	Nepal	HIV menstrual restrictions
(Guha et al., 2012)	400	Adults (in program)	Adults (Female Sex Workers in Chennai, Tamil Nadu, Mumbai, & Maharashtra)	India	Condom use
(O'Conner, 2013)	28	Adults (in program)	Adults (Predominately Hispanic)	United States	Neighborhood participation
(Kuhlmann, Galavotti, Hastings, Narayanan, & Saggurti, 2014)	1,986	Adults (in program)	Adults (Female Sex Workers)	India	Condom use
(Knox, Guerra, Williams, & Toro, 2011)	282	Adults (in program)	Families (Most parents born in Mexico & majority of children born in U.S.)	United States	Child aggression
(McDonell, Ben-Arieh, & Melton, 2015)	229 (wave 1) 326 (wave 2)	Adults (in community)	Community (Urban & rural in South Carolina)	United States	Child abuse

Information on the intervention activities and the use of formative research and theory is shown in Table 2.2. All studies reported multiple intervention activities. Training was implemented most often, followed by communication skills development, group discussion, and

community engagement activities, such as writing and presenting public service announcements, writing letters to the editor of local newspapers, presenting to the local city council (Berg et al., 2009), and conducting public engagements (Carlson et al., 2012).

Table 2. 2. ***Intervention activities by target group***

		Individual level activities							Group level activities						Community level activities		
First author and health outcome of interest	Theory and/or Model used	Formative Research	Communication/ skills	Trainings	Train the Trainer	Research training	Reflection	Volunteering	Discussion	Community Project	Neighborhood Assessment	Self-help groups	Family to family	Train the trainer	Support organizations/ setting	Strengthening community norms	Engagement
Berg (alcohol, sex partners, and marijuana use in youth)	Ecological theory; identity theory; learning and instructional theories; critical, transformative theories	✓	✓		✓	✓	✓		✓	✓	✓					✓	✓
O'Conner (neighboring participation)	Sense of community theory		✓	✓	✓				✓	✓			✓	✓			✓
Posner (HIV knowledge and menstrual restrictions)	Self-efficacy and collective efficacy theory	✓		✓		✓			✓					✓			✓
Carlson (neighborhood problems)	Capability theory; communicative action theory; collective efficacy theory; ecological theory		✓	✓	✓	✓	✓		✓	✓						✓	✓
McDonell (child abuse)	Theory of Change Model (Daro, Huang, & English, 2009)	✓		✓									✓		✓	✓	✓
Guha (condom use)	Collectivism; Social capital theory		✓	✓				✓				✓		✓			
Knox (child aggression)	Social ecological theory; family stress theory; family systems theory	✓	✓	✓		✓			✓				✓				
Kuhlmann (condom use)	Community mobilization theory			✓				✓				✓					
Total for each activity	8	4	5	7	3	4	2	2	5	3	1	2	3	3	1	3	5

Together, 23 activities were targeted at the individual level (e.g., providing training and building communication skills), 17 targeted the group level (e.g., facilitating self-help groups), and 9 targeted the community level (e.g., supporting organizations/settings). One intervention (Knox et al., 2011) trained an established community organization to conduct intervention activities. McDonell (2015) strove to build collective responsibility by mobilizing community

support, and Berg (2009) stressed the engagement of the participants in multilevel community settings and to "attack multiple levels simultaneously" (Berg et al., 2009, p. 356).

Four studies used formative research in their interventions to design or tailor intervention activities and to build trust (Berg et al., 2009; McDonell et al., 2015; Posner et al., 2009) and in one case, to build capacity to deliver intervention activities (Knox et al., 2011). All studies reported at least one guiding theory or framework for the study, including two that identified CE as a theory (Carlson et al., 2012; Posner et al., 2009) and one that identified social capital as a theory (Guha et al., 2012). Five studies reported being guided by multiple theories. For example, Berg (2009) based the intervention on several theories that address empowerment and decision making in youth, along with ecological theory, to inform the intervention approach in working with individuals in groups that "focus on bringing about multi-level changes" (p. 346).

The activities were linked to the five CE building blocks identified in the literature as necessary prerequisites for increasing CE--social bonding, social bridging, social leveraging, empowerment, and civic engagement (Table 2.3). As noted, definitions of these building blocks were used to categorize activities. When the purpose of an activity was not explicated in the article, the reviewers used best judgment to link the activity to a construct.

Table 2. 3. ***Intervention activities by collective efficacy antecedent variables***

	Individual level activities							Group level activities						Community level activities			
Antecedent Variable	**Formative Research**	**Communication/ skills workshops**	**Trainings**	**Train the Trainer**	**Research training**	**Reflection**	**Volunteering**	**Discussion**	**Communitv Proiect**	**Neighborhood Assessment**	**Self-help groups**	**Family to family connections**	**Train the trainer**	**Support organizations/ setting**	**Strengthening community norms**	**Engagement**
Empowerment		✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
Social Bonding		✓				✓	✓	✓			✓	✓			✓	
Social Leveraging	✓	✓	✓				✓					✓		✓		
Social Bridging	✓	✓				✓	✓	✓			✓					
Civic Engagement									✓							✓

Most intervention activities were deemed to impact more than one construct. For example, communication skills workshops should increase social bonding, bridging, leveraging, and also address empowerment. Also, several different activities could promote a single construct. For example, discussions, reflections, and self-help groups can all promote social bonding. The implementation of a variety of activities resulted in CE building blocks being addressed multiple times. Overall, empowerment was the construct that was most impacted by intervention activities, as it was embedded in many of the intervention activities. Few intervention activities aimed to increasing civic engagement, and three interventions did not appear to employ any activities aimed to increase civic engagement.

A variety of scales were used to evaluate the impact of the interventions on CE (Table 2.4). Two of the articles reported using Sampson's (1997) neighborhood CE scale. This scale was used in its entirety (10 items) in one study (McDonell et al., 2015) and was modified in another to only look at the 3-item component "willingness to intervene" (Carlson, Brennan, & Earls, 2012). Berg (2009) modified a community CE scale developed by Israel et al. (1994), and O'Conner (2013) used a 6-item CE scale developed by Perkins (1990). The remaining four studies (Guha et al., 2012; Kuhlman et al., 2014; Knox et al., 2011; Posner et al., 2009) did not indicate the modification of existing CE scales. One study (Guha et al., 2012) only used one item to measure CE (e.g., "If there were a problem that affected all or most of the sex workers community, how many sex workers would work together to deal with the problem?"). While Kuhlman (2014) used four items to measure CE for certain goals, only one item was used to measure the willingness to mobilize. Reliability of the measures (Cronbach's alpha) were reported in all studies but one (Guha et al., 2012). The Cronbach's alpha for Carlson's (2012) child collective efficacy measure was 0.66; the rest were greater than 0.70, indicating good reliability (Berg et al., 2009; Carlson et al., 2012; Knox et al., 2011; Kuhlmann et al., 2014; McDonell et al., 2013; O'Conner, 2013; Posner et al., 2009).

Close examination of the survey items suggested that each could be categorized into one of the five components of CE--social cohesion, social trust, social control, willingness to intervene, and empowerment (Table 2.5). When the author(s) did not explicitly report which component an item aimed to measure, the assignment was determined by the reviewers. Two studies used items that measured only one component of CE, with Carlson (2012) measuring only willingness to act/intervene, and Guha (2012) measuring only social cohesion. Two studies

measured two components, one measured three components, and three studies measured four components. The willingness to act/intervene was evaluated in all but one intervention. Again, it is of note that most interventions measured more than one component of CE. This is to be expected, as interventions activities addressed several CE components. All eight studies reported improvement in at least one measure of CE post-intervention.

Table 2. 4. ***Collective efficacy measurement tools***

First author	Number of items	Response options	Cronbach's alpha	Social Cohesion	Social Trust	Social Control	Willingness to Act/Intervene	Empowerment
Berg	11 items (modified Israel et al, 1994)	4 point Likert scale	0.72			✓		✓
O'Connor	Child - 4 items	4 point Likert scale	0.77		✓			✓
	Neighborhood - 6 items	4 point Likert scale	0.73				✓	
Posner	1 item	5 point Likert scale	NA	✓				
Carlson	Adult - 3 items (Sampson, 1997)	4 point Likert scale	0.70				✓	
	Child – NR (Sampson, 1997)	4 point Likert scale	0.66				✓	
McDonell	4 items (certain goals)	4 point Likert scale	0.73	✓		✓	✓	✓
	1 item (willingness to mobilize)	4 point Likert scale	NA				✓	
Guha	10 items (Sampson, 1997)	4 point Likert scale	0.88	✓	✓	✓	✓	
Kuhlman	6 items (Perkins, 1990)	3 point Likert scale	0.93	✓		✓	✓	✓
Posner	6 items	4 point Likert scale	0.79	✓	✓			

NA – Not Applicable

Table 2. 5. ***Number of activities associated by variable with outcome & collective efficacy indicator***

First author	Antecedent Variables with Outcome and Collective Efficacy						
	Empowerment	Social Bonding	Social Leveraging	Social Bridging	Civic Engagement	Collective Efficacy	Outcome
Berg	✓✓✓✓✓✓	✓✓✓	✓✓	✓✓✓✓	✓✓	+	+
O'Conner	✓✓✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓	+	+
Posner	✓✓✓✓✓	✓	✓✓	✓✓	✓	+	+
Carlson	✓✓✓✓✓✓	✓✓✓	✓✓	✓✓✓✓	✓✓	+	+*
McDonell	✓✓✓✓		✓✓✓	✓	✓	+	+*
Guha	✓✓✓	✓✓✓	✓✓	✓✓✓		+	-/+**
Knox	✓✓✓	✓✓✓	✓✓✓✓	✓✓✓		+/-***	-
Kuhlmann	✓✓	✓✓	✓✓	✓✓		+	-

Note: Each checkmark represents activity implemented addressing antecedent variable
* Small effect size reported
** Positive outcome not seen in all groups
*** Child collective efficacy improved, but parent collective efficacy did not

All eight studies reported improvement in at least one measure of post-intervention CE. Six of the eight studies reported that improvements in community CE were related to improved community health outcomes. Five of the interventions reported statistically significant outcomes, and two articles (Carlson, Brennan, & Earls, 2012; McDonell, Ben-Arieh, & Melton, 2015) reported effect size. Of the eight articles reviewed, seven measured health outcome by self-report surveys created for the study, such as the neighborhood problems scale (Carlson, et al, 2012), and established surveys such as the Social and Health Assessment Instrument (Berg et al, 2009). McDonell (2015), measured child abuse by state statistics and ICD9 codes.

Table 2. 6. ***Intervention Quality Measure (Megens & Harris, 1998)***

	Intervention	Study Design	Inclusion / Exclusion criteria articulated	Program well described	Reliable collective efficacy measures used	Valid outcome measures used	Assessors blinded	Attrition tracked & revealed	Total score	Health Outcome
Tier 1	(Carlson et al., 2012)	Mixed-method, Experimental longitudinal comparison, randomized-controlled trial	✓	✓	✓	✓	✓	✓	**6**	**+***
Tier 1	(Knox et al., 2011)	Mixed-method, Experimental longitudinal comparison, w/ randomization	✓	✓	✓	✓		✓	**5**	**-**
Tier 2	(Berg et al., 2009)	Mixed-method, pre- and 3 post-test, quasi-experimental design w/ matched control	✓	✓	✓	✓		✓	**5**	**+**
Tier 2	(McDonell et al., 2015)	Mixed-method, Two-group pre- and post-test design with comparison sample	✓	✓	✓	✓	✓		**5**	**+***
Tier 2	(Posner et al., 2009)	Pre- and post-test design, no control	✓	✓	✓	✓		✓	**5**	**+**
Tier 2	(O'Connor, 2013)	Mixed-method, cross-sectional, retrospective design, no control	✓	✓	✓	✓		✓	**5**	**+**
Tier 3	(Guha et al., 2012)	Cross-sectional post – test design, matched pairs	✓	✓	✓				**3**	**-/+****
Tier 3	(Kuhlmann, et al., 2014)	Cross-sectional dose-response design	✓	✓	✓	✓			**4**	**-**

*Small effect size

** Positive outcome not seen in all groups

In Table 2.5, the number of intervention activities (indicated with checks), grouped by construct, are juxtaposed with indicators of improvement (or not) in each study's CE measure and community health outcome measure. Of the articles reviewed, it appears that the five interventions that offered activities to improve civic engagement also improved community health, whereas those that did not include civic engagement activities did not show improvement in community health outcomes. One intervention did not address the social bonding variable and, although this intervention showed improved outcomes in child abuse, the survey item of self-reported parenting practices scores did not improve (Knox et al., 2011). Of the studies with improved health outcomes, activities that addressed empowerment were most often implemented.

Findings from the quality rating of each study using the Megens and Harris (1998) quality measure are shown in Table 2.6. Two of the interventions were tested using a randomized trial design, and one scored a perfect 6, and the other 5. Two were tested using a quasi-experimental design and both scored 5. Four were tested using a pre-experimental design with a score of 5 in two of these studies. In all eight studies, sample inclusion and exclusion criteria were well described, the interventions were well described, and the reliability of outcome measures was reported. The least likely quality measure reported was the blinding of the assessors, reported as being done in only two of the eight articles. Thus, six of the 8 studies received scores of 5 or 6 for quality.

Discussion

This review led to four conclusions: (1) improvements in CE were linked to reductions in health disparities; (2) intervention activities impacting all five building blocks of CE yielded better health outcomes than intervention activities impacting fewer CE building blocks; (3) interventions intervening on multiple social ecological levels (individual, group, and community) achieved better health outcomes than interventions intervening on one level; and (4) there is lack of conceptual clarity and operationalization of the CE process model.

Improvements in CE demonstrated reduced health disparities

There was a wide variety of health outcomes addressed in the studies and six of the eight studies reported improvements in the desired health outcome(s). All articles reported increased CE. This supports the prior evidence that "collective efficacy" is a mediating factor in community health outcomes (Browning & Cagney, 2003; Frazini, Caughy, Spears, & Esquer,

2005). The broad and diverse intervention activities that were implemented to address CE building blocks demonstrate the flexibility and adaptability of the CE process. The use of CE to effectively address a variety of health outcomes adds further support to its importance in reducing health disparities.

Intervention activities impacting all five building blocks realized better health outcomes

The CE MAM model, developed from the literature, suggests that interventions need to target all five building blocks--social bonding, social bridging, social leveraging, empowerment, and civic engagement--to improve CE and reduce disparities. This review included studies that featured activities to strengthen least four of the five building blocks. The least often addressed was civic engagement, and two of the three interventions that did not address it failed to show improvements in the health outcomes of interest. While this is interesting, the "mechanism of action" model needs further examination. To test the theoretical assumptions that all building blocks must be addressed, future studies should test interventions that explicitly aim to affect all five building blocks individually and in combination. Examination of which activities could impact all CE building blocks would aid in more thoughtful incorporation of CE intervention into health disparity research and action.

Interventions intervening on multiple social ecological levels achieved better health outcomes

Studies in this review employed a variety of activities that targeted multiple levels, including individuals, groups, and communities. To improve the understanding and usability of CE as a means to improve community health and well-being, this review supports other researchers' recommendations to incorporate intervention activities that address multiple social ecological levels (Golden & Earp, 2012). Intervening at multiple social ecological levels requires a comprehensive coordinated approach to enhance behavior change and influence health outcomes (Ockene et al., 2007). Only one of the articles reviewed (McDonell et al., 2015) engaged the community by recruiting multiple levels (volunteers, community organizations, and institutions) to implement intervention activities.

Lack of conceptual clarity and operationalization of model

The articles demonstrated a lack of clarity in operationalizing CE and linking intervention activities to antecedent variables. In fact, three of the articles in this review mentioned the lack of research on how to operationalize CE concepts into interventions (Berg et al., 2009; Kuhlmann et

al., 2014; O`Conner, 2013). This coincides with findings of a meta-review by Egan and associates (2008) who noted "the lack of consensus regarding the definitions and usage of [these] psychosocial concepts in the research literature (p. 239)." The review conducted by Leroux et al. (2013) concluded that incorporating social- relational constructs beyond the individual level was "dauntingly complex and inaccessible among researchers (p. 8)." This could be the result of the broad and inclusive definition of CE and its building blocks. Lack of conceptual clarity could be linked to lack of clarity in CE theory, and only two interventions (Carlson et al., 2012; Posner et al, 2009) used CE theory to guide intervention activities. Other researchers have noted a lack of consensus on differences between psychosocial concepts, social capital, and CE (Ansari, 2013; Egan et al., 2008) and have recommended that social capital variables and CE components be integrated into existing behavioral theories (Samuel, Commodore-Mensah, & Himmelfarb, 2014). Thus, the CE MAM model may be useful for theory development as well as intervention development.

Overall, this review found only eight peer-reviewed articles reporting on community-level interventions using CE as a mediating factor to address health disparities. Excluded from this review were a number of articles reporting on research that measured CE and associated the findings with health and community statistics, but did not test interventions to improve CE or health disparities (Browning & Cagney, 2003; Frazini, Caughy, Spears, & Esquer, 2005). This is consistent with results found in other literature reviews that have looked at general social constructs and interventions (Egan et al., 2008; Leroux et al., 2013). The lack of community-level interventions targeting CE and/or components of CE was also noted in four of the articles included in this review (Berg et al., 2009; Guha et al., 2012; Kuhlmann et al., 2014; O`Conner, 2013). Although there was not a date limit in this literature review, all of the articles were published within the last six years, indicating that the application of CE in interventions is a new area of study.

There are several limitations of this systematic literature review. First, only peer-reviewed articles were included. There may have been reports of interventions addressing CE and health disparities that were not published subjecting, this review to publication bias. The literature review may have missed peer-reviewed articles based on the search terms used. For example, interventions may have measured a component of CE, but not included the specific term "CE" in the title or abstract. This limitation links to the unclear definition, process, and

measurement of CE. Finally, this review was not intended to be a theoretical examination of CE, but rather a translational review of how to put the concept of CE into practice in intervention delivery and evaluation.

Conclusion

This review found that interventions that utilize CE hold promise to reduce health disparities in communities. The findings also point to the importance of better understanding how CE reduces health disparities. This is especially relevant as the decrease in prevention funding requires more collaborative, grassroots initiatives to effect community change.

CHAPTER 3: INTERVENTION DOSE AND CHANGE IN SCREEN TIME IN THE MULTILEVEL MULTISITE CHILDREN'S HEALTHY LIVING PROGRAM

Abstract

Childhood obesity prevention is a complex issue requiring community-driven interventions addressing multiple levels of the Social Ecological Model (SEM). Determining intervention dose is essential to replicating successful childhood obesity programs, but research estimating multilevel intervention dose is limited. This paper presents a method for estimating intervention dose and demonstrates its usefulness for linking intervention dose to reducing recreational screen time (minutes per day spent watching television or playing computer games) among children in the Children's Healthy Living (CHL) intervention.

Our multisite, multilevel, community-based intervention applied 19 activities to increase physical activity, sleep, water intake, and fruit/vegetable consumption; and to reduce sugar-sweetened beverage intake and recreational screen time in children 2-8 years old living in nine communities in the U.S.-affiliated Pacific. Baseline and 24-month outcome data were collected on 8,407 children. Using data from monthly intervention reports, dose was calculated as the number of activities x relative intervention effectiveness (0.33 for low to 1.00 for high) x the ratio of the number of participants to the intended number of participants. Intervention dose was calculated for each community, year of intervention, type of intervention activity (assessment, environmental change, messaging, and capacity building), and SEM level targeted (individual through policy). To associate dose with outcome, log mean changes in screen time were calculated for intervention and control communities, and Spearman's rho coefficients were estimated between dose and change in screen time before and after the intervention.

Overall intervention dose ranged from 47.5 to 193.1 (sd 47.51). Based on correlation data, reduction in screen time was associated with a greater intervention dose, year of intervention (2^{nd}), type of activity (environmental change), and the SEM level the activity targeted (community) (r_s = -.83 to -.90). This method shows promise for estimating dose in multilevel interventions.

Note: this chapter was submitted to *Preventing Chronic Disease*.

Introduction

Globally, the prevalence of overweight and obesity in preschool-aged children has increased dramatically in the past 25 years (De Onis, Blossom & Borghi, 2010). Overweight or obese children have a higher risk of becoming overweight or obese adults (Singh, et al, 2008) and have an increased risk of chronic disease as they age. Childhood obesity prevention is a complex issue requiring interventions that are community-driven and multi-faceted (Huang, et al, 2009). However, multisite community interventions that address multiple levels of the socio-ecological model (including individual, interpersonal, organizational, community, and policy) present challenges for monitoring, reporting, and estimating "dose" (Cheadle, et al, 2012a; Cheadle et al, 2012b). Determining intervention dose is essential to developing and replicating successful childhood obesity programs and to understanding how interventions impact outcomes. This paper presents a method for estimating intervention dose and demonstrates its usefulness in linking intervention dose to reductions in children's recreational screen time.

Intervention Approach

In a systematic review of the literature, Novotny et al (2013) found high prevalence of overweight and obesity in the United States Affiliated Pacific (USAP)—21% of children at age 2 years and 39% of children at age 8 years. The USAP includes eight jurisdictions: the U.S. States of Alaska and Hawai'i, the U.S. territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands (CNMI); and the U.S. affiliated nations of Palau, the Federated States of Micronesia, and the Republic of the Marshall Islands. To address the growing prevalence of obesity in the USAP region, the United States Department of Agriculture (USDA), Agriculture and Food Research Initiative funded the CHL program for five years (2011-2016) to develop and test a community-driven randomized multilevel intervention. The CHL intervention effect was tested through a community (or cluster) randomized controlled trial (CRCT) in five jurisdictions, where one or two communities (n=9 communities) received the intervention, and one or two matched communities (n=9 communities) served as delayed-intervention controls (Wilken et al, 2013).

The CRCT aimed to evaluate the intervention's impact on anthropometric indicators and acanthosis nigricans, including body mass index (BMI) and waist circumference, as well as six behavioral objectives for children age 2-8 years including increasing fruit and vegetable intake, water consumption, physical activity, and sleep duration, and reducing recreational screen time

and sugar-sweetened beverage consumption (Wilken et al, 2013). Institutional Review Board (IRB) approval or ceding of approval to the University of Hawai‘i at Mānoa was obtained in each jurisdiction.

Based at the University of Hawai‘i at Mānoa, the CHL coordinating center subcontracted with four Land Grant institutions in the USAP (the University of Alaska at Fairbanks, American Samoa Community College, the Northern Marianas College, and the University of Guam) to carry out the objectives of CHL in their respective jurisdictions. As recommended by the ANGELO framework, the multilevel intervention was based on the SEM and was designed by the team by merging community input and evidence-based strategies identified in the literature (Braun et al, 2014; Fialkowski et al, 2014). The intervention package consisted of 19 activities of four types: (1) assessing school wellness policies and the community's physical environment; (2) partnering and advocating for environmental change; (3) promoting CHL messages; and (4) training trainers to promote the six CHL behavioral objectives (Table 1). Although intervention activities were specified, the delivery could be tailored to the community to best fit its cultural preferences and resources. For example, while training trainers was required, the community could pick the specific evidence-based curricula it wished to promote. Over the two-year intervention period, each of the nine intervention communities submitted monthly process reports to the CHL coordinating center. The reports allowed the coordinating center to monitor intervention activities, identify strengths and areas for improvement, and leverage ideas for use in other communities, as well as track intervention progress.

Methods

Large-scale reviews by Keener et al, (2009) and Whitlock et al, (2005) provide evidence-based obesity prevention strategies. However, reports rarely specify the recommended dose needed to affect behavior change. Determining intervention dose presents inherent difficulties. Glasgow (2002) presented a method combining reach and effectiveness to evaluate the impact of interventions, with effectiveness defined as implementation fidelity. A fidelity assessment conducted by the CHL program half-way through the intervention period identified strengths and opportunities to better implement the CHL intervention package (Butel et al, 2015). However, using the CHL fidelity assessment as a component in dose would have considerable limitations due to the timing of the fidelity assessment. In addition, using implementation fidelity as a

component of dose in multilevel, multisite interventions has drawbacks, as it does not consider the potential of the activity to change behavior on a community level.

Also, most estimates of intervention dose focus on individual-level behavior change rather than population-level behavior change (Cerezo, Dasi, & Ruiz, 2013; Goode, Winkler, Reeves & Eakin, 2015). A notable exception was reported by Cheadle (2012a), who defined population dose as "the estimated community-level change in the desired outcome expected to result from a given community-change strategy" (p 74). In other words, it is the product of the reach of the activity into the target population and the expected effectiveness of the strategy on the target population. Cheadle et al, (2012a) applied this population-dose model to Kaiser Permanente's Community Health Initiative to increase physical activity in middle-school students. Strategies were coded as having "low", "medium", or "high" effect potential and the investigators found that communities with a "high dose" had more positive behavioral outcomes (Cheadle et al, 2012a). Building on this work, the CHL team developed an "intervention dose" formula. This approach to dose estimation was tested by examining the relationship between intervention dose and intervention outcome.

Monthly process reports from each of the nine intervention communities were submitted during the intervention phase of the program (January 2013 through December 2014). For reports not submitted 30 days after the due date, CHL coordinating center staff contacted the overdue jurisdiction, and verbal reports were obtained and completed by the CHL coordinating center if possible. Monthly process reports required the jurisdictions to describe what was done, where it was conducted, how many participants were engaged, the progress, and the next steps. These qualitative reports were purposefully broad to capture community tailoring of activities. The report template was loosely based on the RE-AIM (Reach, Efficacy, Adoption, Implementation, and Maintenance) framework, prompting sites to report Reach (number of expected and actual participants), Implementation (types and number of intervention activities), Adoption (number of partners), and Maintenance (next steps) (Glasgow, Lichenstein, & Marcus, 2002). Of the nine communities, two communities filed 24 reports each, while seven communities filed an average of 20 reports over 24 months. Of the missing reports, CHL staff confirmed no activities were conducted in the communities with the exception of four reports involving one community. The missing months were considered to have conducted no activities.

Effectiveness of intervention activities was estimated based on work by Cheadle (2012a; 2012b) and the experience of the CHL intervention leaders (Table 3.1). For example, all "assessment" activities were estimated at 0.33 (low), while most "training the trainer" activities were estimated at 0.67 (medium) because this activity builds the capacity of local champions to promote healthy behaviors. Two of three "messaging" activities were estimated at 0.33 (low), though one related to training and empowering local role models to deliver the CHL messages was estimated as 1.0 (high) because it built capacity. Most "environmental change" activities were estimated at 0.67 (medium), but institutionalizing better food placement in stores and policies/practices for serving water in preschools were estimated at 1.0.

Table 3. 1. ***Potential to change behavior and effectiveness score by activity***

Intervention Activity	Potential to change behavior	Effective-ness	SEM level
CCF 1.Assess Pre-School Policy and Community Environment related to the six CHL behaviors*			
1a. Assess existence and quality of preschool wellness policy	Low	.33	Policy
1b. Assess community physical environment for policy change	Low	.33	Policy
CCF 2. Environmental Change			
2a. Work with orgs/coalitions to advocate for:			
2ai Better access to parks that are safe and inviting	Med	.67	Policy or Community
2aii Better access to clean water	Med	.67	Policy or Community
2aiii Safer environments for walking, biking, etc. (e.g., bike lanes/racks, sidewalks, greenways)	Med	.67	Policy or Community
2aiv Better food placement/availability	High	1	Policy or Community
2av Gardens and hydroponics	Med	.67	Policy or Community
2b Partner with existing entities to purchase or obtain sponsorship for:			
2bi Water in the preschools and childcare centers	High	1	Organizational
2bii Gardening supplies for preschool kids	Low	.33	Organizational or child
2biii Sports equipment for preschool kids	Med	.67	Organizational or child
2biv Campaigns and messages	Low	.33	Organizational
CCF3. Promote the CHL Message			

Intervention Activity	Potential to change behavior	Effective-ness	SEM level
3a Support Role Models to deliver CHL messages in various ways (using the CHL role model curriculum as a guide)	High	1	Community or Caregiver
3b Enhance exiting social marketing campaigns in the intervention communities, and/or develop low-cost local social marking campaigns related to the 6 CHL behaviors	Low	.33	Community
3c Advertise CHL or other activities that promote six CHL target behaviors*	Low	.33	Community, Caregiver, or Child
CCF4. Train the Trainers			
4a Train individuals to promote gardening in preschools and communities	Med	.67	Caregiver, or Child
4b Train individuals to lead interactive, hands-on sessions to promote the six CHL behaviors*	Med	.67	Caregiver
4c Train individuals to organize and lead family-based activities that support the 6 CHL behaviors (park clean-ups, hikes, cooking sessions, etc.)	Med	.67	Caregiver
4d Provide technical assistance to preschool and childcare staff on wellness policies	Low	.33	Policy or Caregiver
4e Train childcare providers and preschool teachers in curricula related to six CHL behaviors*	High	1	Caregiver
4f Train role models (community champions, role celebrities, role models) to promote and provide curricula related to the six CHL behaviors*	High	1	Caregiver

*Increasing physical activity, fruit and vegetable consumption, water consumption, and sleep; and decreasing screen time and sugar sweetened beverage consumption

Targeted SEM level of each activity was determined based on what was written in the report. If the report did not specify the SEM level, the SEM level was determined by who the activity ultimately affected. If a child was affected, the "individual" level was assigned. For activities targeting caregivers (parents, teachers, family members), the "interpersonal" level was assigned. Activities targeting the organization, community, and policy level were assigned to those levels respectively. If the activity affected more than one level, then both levels were assigned. For example, a parent-child gardening activity was assigned to both the interpersonal and the individual level.

For each of the 19 activities, a dose score was calculated using the following equation: *Activity Dose = Number of activities conducted x effectiveness score x total number of participants/intended number of participants.* For example, a billboard promoting the CHL message was posted in the center of a community. The number of activities would be one (1), the

efficacy score would be 0.33, the total number of participants would be one (1) community, and the intended number of participants would be one (1) community. The activity dose equation would be1 x [0.33 x (1/1)], resulting in an activity dose of 0.33. In another example, two trainings on home gardening were conducted in one month, each with 8 participants, although 10 had said they would attend. The number of activities would be two (2), the efficacy score would be 0.67, the total number of participants would be 8, and the intended number of participants would be 10. The activity dose equation would be 2 x [0.67 x (8/10)], resulting in an activity dose of 1.07. All of the calculated dose scores from each community were then summed.

The estimated population of children under age 10 years within the nine intervention communities ranged from 304 to 14,907 (mean 3556.7, sd=4607.4; median 1576). To account for the skewed distribution in population size across communities the log of the population was used to reduce the range of the differences in population size. The dose of the respective communities' intervention was divided by the log of the population.

To consider the effect of other characteristics of the intervention on dose, dose also was calculated by year of the intervention (1^{st} vs. 2^{nd}), by type of activity (assessment, environmental change, messaging, and training to trainer), and by SEM level the activity targeted (i.e., individual to policy). To assess the success of the intervention, mean changes between baseline and 24-month follow-up was estimated by using children's anthropometric indicators (e.g., BMI and waist circumference), behavioral measures (e.g., recreational screen time), and adjusted for sex and age. Anthropometric data was collected based on standardization guidelines [16, 17], and data for other indicators was obtained using validated questionnaires [7]. A mixed linear model was used to account for clustering by community and jurisdiction using F-tests based on 20 degrees of freedom, as the community was the unit of randomization.

For outcome measurements, 180 children at each time point (before and after the 24-month intervention) were recruited within each community. The minimum detectable difference (MDD) in means between intervention and control communities was determined using a statistical simulation approach with a power of 80% and a critical value of 0.05 (two-sided). The simulation allowed CHL to build community structure into the data. The MDD for BMI z-score at 24 months was 0.05; a level of change that has been observed in the literature (de Silva-Sanigorski et al, 2009). The MDDs for the other outcomes was 0.18 for servings of fruits and vegetables, water and sugar-sweetened beverages, and 10 minutes for sleep and sedentary

activity, which was less than the targeted change. However, based on preliminary analysis, recreational screen time decreased in intervention communities and increased among control communities. Screen time was measured through a modified six-item questionnaire (Buckworth & Nigg, 2004) completed by child parent or caregiver. Log transformation was used to reduce skewness in the data, and log mean screen time was adjusted for child age, sex, and race (e.g. Black or African American; White; American Indian or Alaska Native; Asian; Native Hawaiian or other Pacific Islander).

Spearman's rho (r_s) was used to estimate the relationship between population-adjusted intervention dose and change in adjusted log mean screen time from baseline to 24 months. This correlation was estimated for the overall intervention dose and then stratified by year of intervention, type of intervention activity (assessment, environmental change, messaging, and training to trainer), and SEM level the activities targeted. SAS 9.4 was used for analysis.

Results

The community intervention dose across the nine intervention communities ranged from 47.51 to 198.13, with a mean of 87.60 (standard deviation [sd] 46.05), and a median of 80.14 (Table 2). Three intervention communities had an intervention dose of less than 70, four intervention communities had a dose between 70 – 100, and two intervention communities had a dose of greater than 100. The mean dose by type of activity is also shown in Table 3.2. For all intervention communities, dose was higher in Year 2 than in Year 1. This makes sense because it took communities time to gear-up their activities, recruit champions and role models, and work with coalitions to promote change. Looking by type of activity, dose was lowest for assessment activities (which were done infrequently), but served to guide activities in other areas. This was true for each intervention community and for the CHL intervention as a whole. Overall dose was highest in the area of environmental change because CHL strived to facilitate environmental change and because these activities were estimated to have a relatively high "effectiveness" (Cheadle, et al, 2012a; Cheadle et al, 2012b). Overall dose was intermediate for messaging and training trainer activities, but no clear pattern was seen for the intervention communities. In fact, each intervention community showed a somewhat different pattern in the types of activities they promoted; community 3 focused more on messaging and training trainers, community 4 focused primarily on environmental change and messaging, and community 8 focused on environmental change and training trainers (Table 3.2).

Table 3. 2 ***Overall and Grouped Activities Dose and Change in Screen Time by Community***

	Total	Com 1	Com 2	Com 3	Com 4	Com 5	Com 6	Com 7	Com 8	Com 9
Overall dose (all activities, all years)	87.60	47.51	52.70	53.47	71.69	80.14	86.47	88.62	108.73	198.13
Year of intervention										
Year 1	25.33	12.26	11.46	15.27	7.52	23.66	13.71	31.2	37.22	74.72
Year 2	62.57	36.44	41.23	58.42	46.42	53.81	73.42	58.43	71.52	123.42
Type of activity										
Assessment	4.95	1.56	1.32	4.97	4.97	2.46	5.99	1.33	4.96	16.99
Environmental Change	33.59	15.19	21.53	18.07	27.46	24.07	40.92	54.01	35.07	66.01
Messaging	23.59	17.89	12.91	25.68	17.82	21.88	22.42	21.74	10.71	61.22
Training Trainers	25.37	12.87	16.94	22.97	3.22	31.73	17.14	11.54	57.99	53.91
Targeted SEM level										
Individual (child)	4.00	0	2.65	5.97	0	0.67	10.20	2.28	1.34	12.93
Interpersonal (caregiver)	12.11	1.94	21.88	20.45	0.67	2.84	6.83	3.20	25.53	25.71
Organization	11.52	12.72	2.81	3.67	7.02	18.20	13.28	15.14	11.71	19.10
Community	55.53	33.71	24.04	40.95	40.95	54.78	55.16	67.67	68.17	123.31
Policy	3.63	0.33	1.32	2.64	5.3	0.99	1.66	1.33	1.99	17.09
Adjusted log mean change in screen time	-.02	.15	.13	.01	-.04	-.05	-.16	-.14	-.06	-.08

Looking by targeted SEM level, overall and community doses were largest for activities aimed at the community level, and lowest for activities aimed at the individual (child) and policy levels. However, wide variation was seen across communities in dose for activities targeting all levels of the SEM, including a range in dose from 0 to 12.93 for activities targeting the individual (child) level, 0.67 to 25.71 for activities targeting the interpersonal (caregiver/teacher) level, 2.81 to 19.10 for activities targeting the organization level, 24.04 to 123.31 for activities targeting the community level, and 0.33 to 17.09 for activities targeting the policy level.

Changes in adjusted screen time log means, from baseline to 24 months, also are shown in (Table 2). Overall, there was a statistically significant reduction in screen time (-0.02 average adjusted log mean) in the intervention communities and an increase of 0.09 (not shown in table) in the control communities. As with dose, there was variation in the adjusted log mean change in screen time across communities, with communities 1, 2, and 3 reporting increases, and communities 4, 5, 6, 7, 8, and 9 reporting decreases.

Community dose by outcome correlations are shown in Table 3.3. Spearman's correlation between overall dose and change in screen time was rs= -0.85 (CI -0.96, -0.38), meaning the higher the dose, the greater the reduction in adjusted log mean change in screen time. Overall dose and change in screen time was also significant for Year 2 (rs= -0.90, CI -0.98, -0.55), for environmental change activities compared to other intervention activities (rs= -0.85, CI -0.96, -0.38), and for activities targeting the community level of the SEM compared to activities targeting other levels (rs= -0.83, CI -0.96, -0.32).

Discussion

Significant differences in the delivered dose of the CHL intervention package across the intervention communities were found. Overall, there was a statistically significant inverse relationship between community intervention dose and amount of screen time in young children. The correlation between intervention dose and screen time had a strong effect (Cohen, 1992). The activities with the strongest effect size ($rs \geq -0.85$) included activities aimed at environmental change, activities with a community-wide focus, and activities that were conducted in the second year of the intervention.

Table 3. 3. ***Relationship between Dose and Change in Log Mean Screen Time***

	r_s	CI (95%)
Year of Intervention		
Year 1	-.63	(-.91, .09)
Type of activity		
Assessment	-.44	(-.85, .33)
Environmental Change	-.85	(-.96, -.38)
Messaging	-.43	(-.84, .34)
Targeted SEM level		
Individual (child)	-.59	(-.89, .16)
Interpersonal (caregiver)	-.35	(-.81, .43)
Organization	-.60	(-.90, .14)
Community	-.83	(-.96, -.32)
Policy	-.33	(-.81, .44)

These findings suggest that the combination of activities in the intervention package may have been related to the decrease in screen time. As other researchers have noted, comprehensive intervention packages are more effective than single-activity interventions in impacting complex programs like childhood obesity (Cerezo, Dasi, & Ruiz, 2013; Goode, Winkler, Reeves & Eakin, 2015). The CHL social marketing campaigns focused on all of the target behaviors with different messages in different months (e.g., one month might have introduced the suggested behavior, followed by messages on the health benefits of the behavior and tips on behavior change). The combination of hearing a CHL message, delivered by role models, and followed up by environmental or organizational change could be a potential reason for the strong correlation and effect size between intervention dose and change in screen time.

This method of estimating intervention dose--using data from monthly process reports based on the RE-AIM concepts of reach, implementation, and adoption--holds promise for evaluating large multilevel interventions in communities. This method complements the population-dose model suggested by Cheadle (2012a) in that it has the ability to estimate the

dose based on quantified activities. The estimated community intervention dose could be further refined as more knowledge of the impact of activities to change behavior becomes available. This dynamic tool has potential to assist in determining how much and which types of intervention activities are needed to achieve positive health outcomes in community. Further development and testing of the community intervention dose tool are needed.

Limitations

This study has several limitations. First, recording activities in large multilevel, multisite interventions is challenging due to the number and scope of activities taking place. The intervention monthly process reports were completed by jurisdiction-based CHL staff with input from community partners who, in many instances, were implementing the intervention activities. This could have led to inaccurate reporting of activities, in particular in reporting numbers of actual and intended participants. The CHL intervention leaders sought to streamline the reporting process to assist in completing the monthly process reports. However, some reports were delayed, and activity participation could have been over- or underestimated. Communities with missing reports could have been conducting activities that did not get counted. Communities also may have interpreted an "activity" very rigidly, and not reported actions done to "prepare" for activities, such as talking to stakeholders and coalitions about activities they could pursue together. Efforts were made to secure missing reports by calling the jurisdictions. The estimated effect of the missing reports on the analysis is minimal as a majority of missing reports were confirmed to have no activities conducted. Even though the monthly process reports had limitations, the reports allowed the coordinating center staff to look for gaps and address them in a consistent way with jurisdiction staff, both individually and as a group, during monthly CHL-wide conference calls. In addition, the reports were developed with the concepts of RE-AIM and allowed for the coordinating center staff to more easily quantify the reports. The monthly reports were quantified at the coordinating center, not by those completing the reports. This may have resulted in the misclassification of activities, although a protocol for quantifying the reports was established to mitigate this potential bias.

Another limitation was the assumptions made on estimating the potential for each activity to change behavior. The lack of literature to guide these determinations required the CHL intervention leaders to estimate potential impact based on their expert judgement. This may have led to inaccurate effectiveness scores for each activity.

Despite the limitations, finding a strong negative correlation between a community intervention dose and children's recreational screen time suggests that our template for monthly reporting and our formula for estimating community intervention dose should be considered by other researchers.

Conclusion

Childhood obesity prevention is complex, as is the implementation and evaluation of multilevel, multisite, community-driven interventions. Attempts to capture and report intervention activities, quantify the activities, and estimate community intervention dose have rarely been made. Unfortunately, this combination of issues hinders our ability to replicate successful multilevel interventions and to understand how multi-component interventions impact outcomes. The CHL program incorporated RE-AIM concepts into a systematic method of reporting and quantifying intervention activities and determining dose of a multilevel intervention aimed to improve child health. Finding a strong negative correlation between a community intervention dose and children's recreational screen time suggests that this approach holds promise and should be further tested.

CHAPTER 4. MEASURING DOSE AND ORDERING OF COLLECTIVE EFFICACY BUILDING BLOCKS USING THE MULTILEVEL MULTISITE CHILDREN'S HEALTHY LIVING PROGRAM INTERVENTION

Abstract

Communities with high collective efficacy (CE) demonstrate high social cohesion and willingness to take action to improve community outcomes. Processes to increase community CE are not well understood. This study examined data from the multisite Children's Healthy Living (CHL) project to: 1) estimate CE dose; 2) examine if CE dose correlates with reduction in children's recreational screen time; and 3) determine if the order in which CE building blocks are addressed correlate with outcome using regression analysis. There was a significant correlation (r_s) between change in screen time and CE dose (r_s=0.83, p=0.003). Communities with high CE dose had a regression slope line with a larger rate of increase for civic engagement than communities with low CE dose. Civic engagement activities were key to community change and required time to implement.

Introduction

Collective efficacy (CE) is defined as "social cohesion among neighbors combined with their willingness to intervene on behalf of the common good" (Sampson, Raudenbush, & Earls, 1997, p. 918). Social cohesion consists of social capital (bonding, bridging, and leveraging), and the willingness to act/intervene involves empowerment and civic engagement (Collins, Neal, & Neal, 2014). These are known as the five CE antecedent variables, but will be referred to in this paper as CE building blocks. Social bonding requires social trust and association, whereas social bridging consists of more distant ties to other groups in the community (Larson, 2004). Social leveraging links the community to people or groups in positions of power and/or resources (Woolcock, 2001). Empowerment builds capacity to make choices and turn them into desired outcomes (Alsop & Heinsohn, 2005). Civic engagement is where community members or groups take part in policy and/or community change (Collins et al., 2014).

CE shows promise in improving health outcomes. For example, communities with higher CE have lower prevalence of obesity, depression, and risk-taking behaviors, and lower rates of morbidity and mortality when compared to similar communities with low CE (Cohen, Finch, Bower, & Sastry, 2006; Kimbro, Brooks-Gunn, & McLanahan, 2011; Skrabski, Kopp, & Kawachi, 2004; Smith, Osgood, Caldwell, Hynes, & Perkins, 2013). There has been some

research examining how social capital can increase social cohesion and CE (Beck, Ohmer, & Warner, 2012; Collins, Neal, & Neal, 2014; Domínguez & Arford, 2010). However, increasing CE in communities is complex and entails intervening at multiple levels of the socio-ecological model (SEM)--including individual, interpersonal, organizational, community, and policy (Butel & Braun, 2016). There is a lack of research on how to operationalize CE concepts into interventions (Berg, Coman, & Schensul, 2009; Kuhlmann, Galavotti, Hastings, Narayanan, & Saggurti, 2014; O'Connor, 2013), especially regarding using CE as a focus of change and a unit of measure in multilevel community interventions.

Strategies to increase CE have not been well described, and the approach and definition can be applied in numerous ways (Samuel, Commodore-Mensah, & Dennison Himmelfarb, 2014). A systematic literature review by Butel (2016) found a lack of conceptual clarity and operationalization of CE. This coincides with findings of a meta-review (Egan, Tannahill, Petticrew, & Thomas, 2008) which noted "the lack of consensus regarding the definitions and usage of [these] psychosocial concepts in the research literature (p. 239)." In another review, Leroux, Moore, & Dube, 2013 concurred, noting that incorporating social relational constructs beyond the individual level was "dauntingly complex and inaccessible among researchers" (p. 8).

Based on the literature, a model of the CE mechanism of action was developed (Butel & Braun, 2016) (Figure 4.1). The literature review conducted by Butel & Braun (2016) found no published literature examining the dose of CE building block activity in interventions. However, the review did identify intervention activities--such as hands-on training, leadership development, peer mentorship, community events, directed projects, and advocacy—that can strengthen the five CE building blocks. These activities were shown to improve overall CE (social cohesion and willingness to act) and health outcomes. However, no published literature was found on recommended "dose" of CE building block activity in interventions.

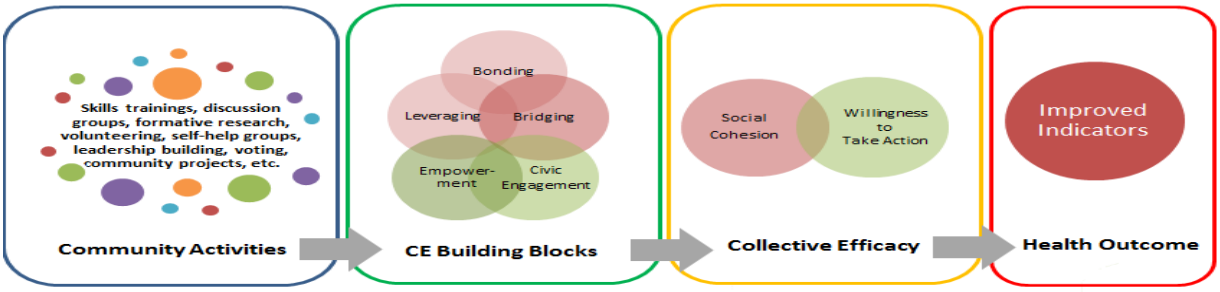


Figure 4. 1. ***Collective Efficacy Mechanism of Action Model (CE MAM)***

Comprehensive analysis of complex interventions can serve as a guide to exploring the quantity of intervention activities in CE guided interventions. The Children's Healthy Living (CHL) program was a complex multilevel, multisite intervention aimed at preventing young child obesity. CHL intervention effect was tested through a community randomized controlled trial (CRCT) in five jurisdictions (Alaska, American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and Hawai'i), where nine communities received the intervention, and nine matched communities served as delayed-intervention controls (Wilken et al., 2013). Institutional Review Board (IRB) approval or ceding of approval to the University of Hawai'i at Mānoa was obtained in each jurisdiction.

The CRCT aimed to evaluate the intervention's impact on anthropometric indicators including body mass index (BMI) and waist circumference, acanthosis nigricans, and six behavioral objectives for children age 2-8 years, including increasing fruit and vegetable intake, water consumption, physical activity, and sleep duration; and reducing recreational screen time, and sugar-sweetened beverage consumption (Wilkens et al, 2013). The intervention had a preliminary significant positive effect on decreasing acanthosis nigricans, waist circumference, overweight status, and recreational screen time (Novotny et al, 2017).

The purpose of this study was to address gaps in the CE literature by 1) presenting a way to estimate CE dose for each community, as well as the dose for each of the five CE building blocks (social bonding etc.); 2) examining the usefulness of a CE dose measure by seeing how overall CE dose and the dose of the five CE building blocks in the CHL intervention correlate with change in screen time and; 3) determine if the order in which CE building blocks are addressed correlate with outcome. In chapter 3, intervention dose was calculated using principles of the RE-AIM (Reach, Efficacy, Adoption, Implementation, and Maintenance) model, with the dose score being calculated using the following equation: *Activity Dose = Number of activities conducted x effectiveness score x total number of participants/intended number of participants.* The purpose of this dose calculation was to present a method for estimating intervention dose and demonstrated its usefulness in linking intervention dose to reductions in children's recreational screen time.

Here, the CE dose builds on the intervention dose by determining the extent each activity addressed the CE building blocks. The purpose of examining CE dose is to determine if overall CE dose and the dose of the five CE building blocks in the CHL intervention correlate to a

reduction in screen time. This is important, as it will help assess the applicability and usefulness of CE MAM in affecting behavioral change.

Materials and Methods

Over the 2-year intervention period program (January 2013 through December 2014), each of the nine CHL intervention communities submitted monthly process reports to the CHL coordinating center. Of the nine communities, two communities filed 24 reports each, while seven communities filed an average of 20 reports over 24 months. Of the missing reports, CHL staff confirmed no activities were conducted in the communities with the exception of four reports involving one community. The missing months were considered to have conducted no activities.

As noted in Chapter 3, data from the monthly intervention process reports were used to estimate CHL intervention dose, using this formula -- the number of activities x relative intervention effectiveness (0.33 for low to 1.00 for high) x the ratio of the actual to intended number of participants (Butel, Braun, Nigg et al, 2016). Intervention dose was calculated monthly for each community for the 2-year intervention. Preliminary testing of the dose formula found a direct, inverse relationship between community intervention dose and recreational screen time, i.e., the higher the dose, the greater the decrease in reported screen time among young children (Butel, Braun, Nigg et al, 2016; also see Chapter 3).

For Chapter 4, monthly process reports also were used to determine which CE building block(s)--social bonding, social bridging, social leveraging, empowerment, and civic engagement—was addressed by each implemented activity. A community gardening activity, for example, may have brought community members together (social bonding) with extension workers (social bridging) and secured free gardening materials and supplies for the community (social leveraging). Another activity may have trained community members in advocacy (empowerment) and helped them present an issue to government officials (civic engagement). More simply, social bonding was defined as activities that helped develop strong relationships within the community, social bridging activities as those that reached out to diverse groups within the community, social leveraging activities as those that utilized resources from organizations outside the community, empowerment activities as those that transferred new skills to community members, and civic engagement activities as activities that promoted policies favorable to childhood obesity prevention and activities that created changes in the community.

A rubric was developed with anchoring vignettes to determine the extent to which level of an activity addressed each CE building block. Because the CE building blocks concepts are difficult to quantitatively measure, the vignettes provided scale anchors that enabled activity comparisons. There were five statements for each building block to determine the building block achievement level. The five anchoring vignettes related to the following levels: 1) not addressed; 2) addressed a little; 3) addressed somewhat; 4) mostly addressed; 5) completely addressed. A weighted value of 0, 0.25, 0.5, 0.75, or 1.0 was assigned, respectively (Table 4.1).

Assignment of the CE building block levels and scores were made using the following protocol: 1) Read text in the "what was done" column of the monthly intervention process reports; and 2) Identify the anchoring vignette that best fit the texts for each CE building block. For example, a monthly report stated *"Community Leaders attended Food Safety Training and received certification from BOH (Board of Health)"*. Because the activity completely focused on skill building, a weighted value of 1.0 for empowerment was given. The second reviewer completed a validation check of each community's scoring initially done by the primary reviewer. The two reviewers discussed and resolved scoring differences. There was a 96% agreement between the two reviewers, with the remaining 4% of the scores achieving agreement following discussion.

Table 4. 1. CE *Building Block Rubric*

	Not at all 0	A little 0.25	Somewhat 0.50	A lot 0.75	Completely 1
Social Bonding (e.g., built strong relationships in the community)	Building strong relationships not addressed	Little relationship building addressed	Some relationship building addressed	Considerable relationship building included	Activity completely focused on building strong relationships
Social Bridging (e.g., included different groups)	Did not include another group	Group(s) with many similarities included	Somewhat similar group(s) included	Included a few diverse groups	Several diverse groups included
Social Leveraging (e.g., secured outside resources)	No utilization of outside resources	Little use of outside resources	Some use of outside resources	Considerable use of outside resources	Mainly consisted of outside resources
Empowerment (e.g., skills building)	Not addressed	Activity focused a little on skills building	Skills building was secondary to the activity	Skills building was a primary focus	Activity completely focused on skills building
Civic Engagement (e.g., actively worked toward policy and/or community change)	Not addressed	Discussed policy and/or community change but not primary to activity	Planned for future policy and/or community change	Very involved with policy and/or community change but not currently active	Actively worked toward targeted policy and/or community change

The assessed weighted value for each activity was multiplied by the respective activity dose (described above) to obtain a dose of each CE building block (social bonding, social bridging, social leveraging, empowerment, and civic engagement) for each community. A dose for each of the five CE building blocks was accumulated from all implemented activities. The overall community CE intervention dose was the sum of all five CE building block doses.

One outcome variable that improved more in the intervention than control communities was recreational screen time, which decreased in intervention communities and increased in control communities (Novotny et al., 2017). Screen time was measured through a modified six-item questionnaire (Buckworth & Nigg, 2004) completed by child's parent or caregiver. The unit of analysis in the CHL intervention was the community. CHL outcome changes were calculated using statistical models that included adjustments for sex and age, accounted for sample weights, and stratified on the community level. Sex and age variables were used to adjust prevalence estimates because previous research established sex and age as significant predictors of BMI among children (Hammer, Kraemer, Wilson, Ritter, & Dornbusch, 1991). Sample weights were constructed for each CHL participant to relate how many individuals in their respective community each participant's answer represented. Individual case weights were created in order to produce more accurate population estimates from the study sample and involved the reciprocal of the probability of selection. Participants were sampled using a stratified sampling method in order to better measure prevalence estimates for each of the CHL communities. Consequently, the analysis model included stratifying the results by CHL community. To reduce the effect of extreme scores, the log mean of screen time was estimated and used as the outcome variable in this study. The log mean is a measure of central tendency that computes the arithmetic mean of logarithm-transformed values. Spearman's correlation (the method used to correlate community intervention dose to screen time in Chapter 3) was used to estimate the relationship between CE intervention dose and change in adjusted log mean screen time from baseline to 24 months. This correlation was estimated for the overall CE intervention dose.

Cross-case analysis of reports from the nine CHL intervention communities provided an opportunity to explore the quantity of CE building blocks that were implemented in CHL intervention activities and link this quantity to outcomes. To study the order of CE building block implementation, the intervention dose of each building block was examined for each of the nine CHL intervention communities at four time intervals (6, 12, 18, and 24 months) after the

start of intervention activities. Spearman's correlation was used to estimate the relationship between each CE building block at each time interval and change in adjusted log mean screen time from baseline to 24 months. The adjusted log mean removed outliers due to their large impact on the log mean.

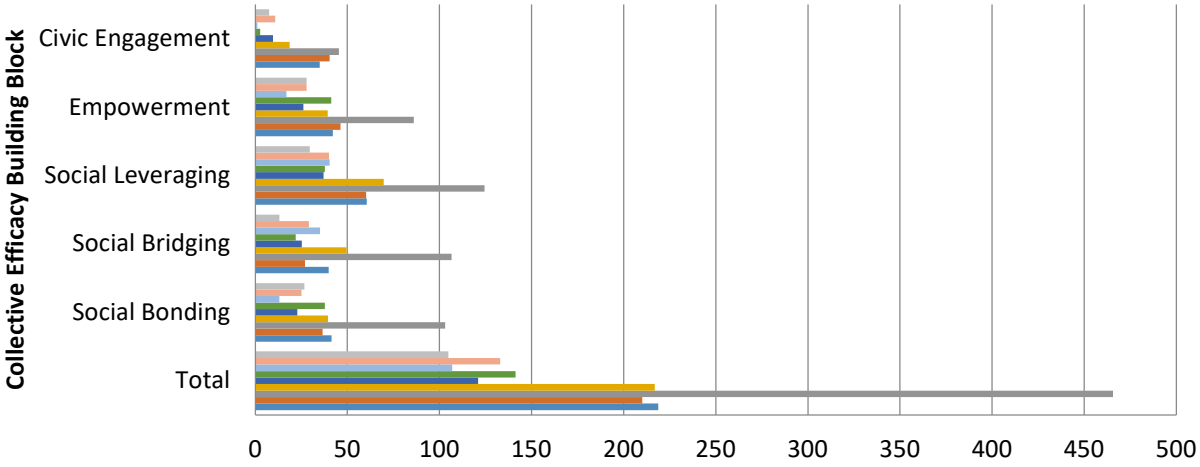
To further explore the implementation order, the communities were divided into two groups. The division was based on a distinct break in total CE intervention dose between groups of communities. Communities with an overall CE intervention dose of greater than 200 were placed in the "high" group and communities with an overall CE intervention dose of less than 200 were placed in the "low" group. Group means were calculated for overall CE intervention dose and dose of each CE building block and total CE dose and dose of each CE building block for the four time intervals. To determine if there was a difference in the group means, a two-tailed t-test was performed. Mixed regression analysis techniques, accounting for repeated measures, were used to determine if there was a difference in rate of implementation across groups, based on differences in linear trends. SAS 9.4 was used for analysis.

Results

Sum of CE Doses

The CE intervention dose totals across the nine intervention communities ranged from 104.78 to 465.60, with a mean of 190.92 (Figure 4.2). Four communities had an overall CE intervention dose of greater than 200 (range 210 to 466) and five communities had an overall CE intervention dose of less than 200 (range 105 to 141) (Figure 4.2). The four communities with doses of >200 had the greatest change in log mean screen time (range -0.16 to -0.06, mean -0.11). In the five communities with CE doses of <200 screen time change was less (0.15 to -0.05, mean 0.04).

For all intervention communities, dose was highest for social leveraging (499.54) and lowest for civic engagement (171.21) with social bonding, social bridging and empowerment having similar doses (345.96, 347.76, and 353.83, respectively).The dose for each specific CE building block is also shown in Figure 4.2.

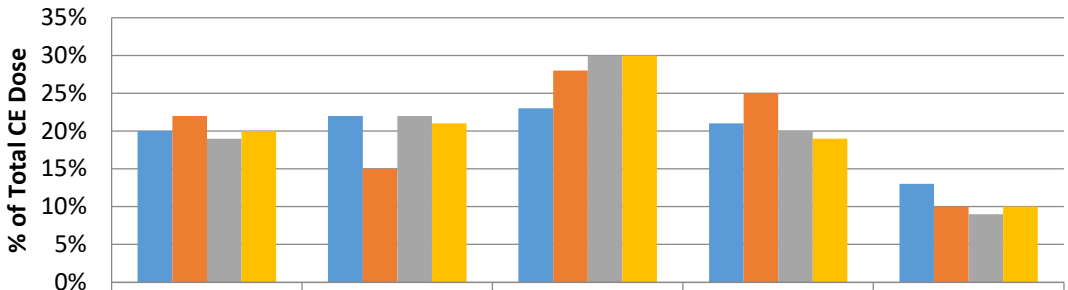


	Total	Social Bonding	Social Bridging	Social Leveraging	Empowerment	Civic Engagement
Cmty 9	104.78	26.6	13.17	29.65	27.86	7.51
Cmty 8	132.99	25.1	29.11	40.02	27.93	10.83
Cmty 7	106.95	13.18	35.23	40.38	16.99	1.16
Cmty 6	141.26	37.7	22	37.78	41.19	2.6
Cmty 5	120.98	22.87	25.24	37.07	26.09	9.7
Cmty 4	216.82	39.55	49.58	69.69	39.36	18.69
Cmty 3	465.6	103.12	106.58	124.44	85.99	45.46
Cmty 2	210.1	36.47	26.98	60.09	46.27	40.29
Cmty 1	218.81	41.36	39.87	60.47	42.14	34.97

*Communities were ordered based on change in screen time. Community 1 realized the greatest decrease in screen time.

Figure 4. 2. ***Collective Efficacy Intervention Dose by Community***

To assess the implementation order for all nine intervention communities, the doses were summed by intervention time interval (Figure 4.3). The percent of the total dose for the building blocks was similar at each time interval reflecting no definitive order to implementation of CE building blocks CHL-wide (Figure 4.3). The highest percentage of dose was in social leveraging and the lowest was in civic engagement. The percentage of dose due to social bonding, social bridging, and empowerment was comparable across the time intervals.



	Social Bonding	Social Bridging	Social Leveraging	Empowerment	Civic Engagement
T1	20%	22%	23%	21%	13%
T2	22%	15%	28%	25%	10%
T3	19%	22%	30%	20%	9%
T4	20%	21%	30%	19%	10%

T1 (0-6 months); T2 (6-12 months); T3 (12-18 months); T4 (18-24 months)

Figure 4. 3. ***CHL-Wide CE Building Block Percentage of Total Collective Efficacy (CE) Dose by Time Intervals (n=4 time intervals)***

Correlation to Screen Time

CE intervention dose varied notably across the communities. Overall, there was a statistically significant inverse relationship between CE intervention dose and log mean screen time in young children (2 to 8 years old). Spearman's correlation (r_s) between overall CE intervention dose and change in screen time was r_s = -0.83 (CI -0.96, -0.33). The correlation between CE intervention dose and adjusted log mean screen time had a strong negative relationship (Cohen, 1960). The correlations between each CE building block dose and change in log mean screen time are shown in Table 4.2. Similar correlations were found with community intervention dose, rs= -0.85 (CI -0.96, -0.38) (Chapter 3).

Change in screen time was significantly correlated with the CE building blocks of social leveraging, empowerment, and civic engagement (r_s= -0.72, -0.72, and -0.75, respectively). Examination of the four time intervals showed a significant correlation to change in screen time at time intervals one and three. However, not all CE building blocks showed significant correlations to change in screen time. At time interval one, social bonding (r_s= 0.72, -.93, -.06) and empowerment (r_s= 0.63, -.90, -.10) had significant correlation to change in screen time. At time interval three, social leveraging (r_s= -0.82), total CE (r_s= -0.77), civic engagement (r_s= -0.75), and social bridging (r_s= -0.72) were significantly correlated to screen time at a confidence

interval of 95%. At time intervals two and four the correlations were not significant to change in mean log screen time, as measured from baseline to 24 months.

Table 4. 2. ***Spearman's Correlation between Overall Collective Efficacy Intervention Dose and Component Doses and Change in Log Mean Screen Time (hours/day)***

	r_s	CI (95%)
Overall		
Total Collective Efficacy	**-0.83**	**(-.96, -.33)**
Social Bonding	-0.65	(-.91, .07)
Social Bridging	-0.55	(-.88, .21)
Social Leveraging	**-0.72**	**(-.93, -.06)**
Empowerment	**-0.72**	**(-.93, -.06)**
Civic Engagement	**-0.75**	**(-.94, -.13)**
Time Interval 1 (0-6 months)		
Total Collective Efficacy	-0.65	(-.91, .07)
Social Bonding	**-0.72**	**(-.93, -.06)**
Social Bridging	-0.43	(-.84, .35)
Social Leveraging	-0.52	(-.87, .25)
Empowerment	**-0.63**	**(-.90, -.10)**
Civic Engagement	-0.29	(-.83, .38)
Time Interval 2 (6-12 months)		
Total Collective Efficacy	-0.42	(-.84, .36)
Social Bonding	-0.07	(-.70, .63)
Social Bridging	-0.15	(-.74, .58)
Social Leveraging	-0.62	(-.90, .12)
Empowerment	-0.25	(-.78, .51)
Civic Engagement	-0.58	(-.89, .18)
Time Interval 3 (12-18 months)		
Total Collective Efficacy	**-0.77**	**(-.94, -.16)**
Social Bonding	-0.68	(-.92, .01)
Social Bridging	**-0.72**	**(-.93, -.06)**

	r_s	CI (95%)
Social Leveraging	**-0.82**	**(-.96, -.29)**
Empowerment	-0.63	(-.91, .09)
Civic Engagement	**-0.75**	**(-.94, -.16)**
Time Interval 4 (18-24 months)		
Total Collective Efficacy	-0.57	(-.89, .19)
Social Bonding	-0.62	(-.87, .28)
Social Bridging	-0.27	(-.78, .50)
Social Leveraging	-0.33	(-.81, .44)
Empowerment	-0.27	(-.78, .50)
Civic Engagement	-0.50	(-.90, .12)

Difference in Means between Groups

To further explore the order of CE building block implementation, the nine communities were placed into two groups. Communities with a total CE of >200 were placed in the "high" group (n=4) and communities with a total CE dose of <200 were placed in the "low" group (n=5). Differences in means were compared between groups for the total CE dose, the dose for each building block at each time period, and overall doses (Table 4.3). There was a significant difference in means between the two groups for overall empowerment and civic engagement with borderline significance for total CE, social bridging, and social leveraging. Time periods two, three, and four had significant differences in means for civic engagement with time period two showing significant differences in social leveraging and empowerment.

Table 4. 3. ***Mean Differences between High (n=4) and Low (n=5) Dose Collective Efficacy Groups***

	Group mean (s.d.)		**p-value**
Overall	High	Low	
Total CE	277.8 (125.2)	121.4 (15.9)	0.09**
Social Bonding	55.1 (32.1)	25.1 (8.8)	0.15
Social Bridging	55.8 (35.1)	25.0 (8.2)	0.10**
Social Leveraging	78.7 (30.8)	37.0 (4.3)	0.07**
Empowerment	53.4 (21.9)	28.0 (8.6)	**0.05***
Civic Engagement	34.9 (11.6)	6.4 (4.3)	**0.001***
Time Interval 1(0-6 months)			
Total CE	31.0 (40.3)	7.0 (0.4)	0.32

	Group mean (s.d.)		p-value
Overall	High	Low	
Social Bonding	6.8 (8.7)	0.9 (1.2)	0.27
Social Bridging	6.5 (8.7)	2.0 (1.9)	0.38
Social Leveraging	6.2 (8.3)	2.3 (1.7)	0.33
Empowerment	7.1 (8.9)	1.0 (1.3)	0.26
Civic Engagement	4.3 (5.8)	0.8 (0.7)	0.31
Time Interval 2 (6-12 months)			
Total CE	59.7 (34.2)	19.7 (9.4)	0.10**
Social Bonding	12.8 (10.0)	4.7 (2.8)	0.23
Social Bridging	8.4 (7.8)	3.4 (1.0)	0.29
Social Leveraging	17.4 (8.1)	5.3 (1.9)	**0.05***
Empowerment	14.4 (7.2)	5.3 (3.7)	**0.04***
Civic Engagement	6.6 (4.1)	1.0 (1.4)	**0.02***
Time Interval 3 (12-18 months)			
Total CE	101.9 (53.4)	44.1 (18.7)	0.06**
Social Bonding	18.6 (13.0)	9.1 (5.7)	0.19
Social Bridging	23.2 (14.1)	9.1 (6.3)	0.09**
Social Leveraging	29.9 (15.2)	13.5 (7.2)	0.07**
Empowerment	17.2 (9.5)	10.9 (5.5)	0.25
Civic Engagement	12.9 (6.7)	1.5 (1.5)	**0.04***
Time Interval 4 (18-24 months)			
Total CE	85.3 (50.8)	50.6 (20.5)	0.07**
Social Bonding	16.7 (5.2)	10.4 (4.4)	0.08**
Social Bridging	17.7 (8.2)	10.4 (7.3)	0.20
Social Leveraging	25.1 (5.8)	15.9 (7.9)	0.09**
Empowerment	14.7 (5.0)	10.9 (4.5)	0.26
Civic Engagement	10.0 (4.8)	3.0 (3.4)	**0.02***

* Significant difference in mean ($p \leq 0.05$)

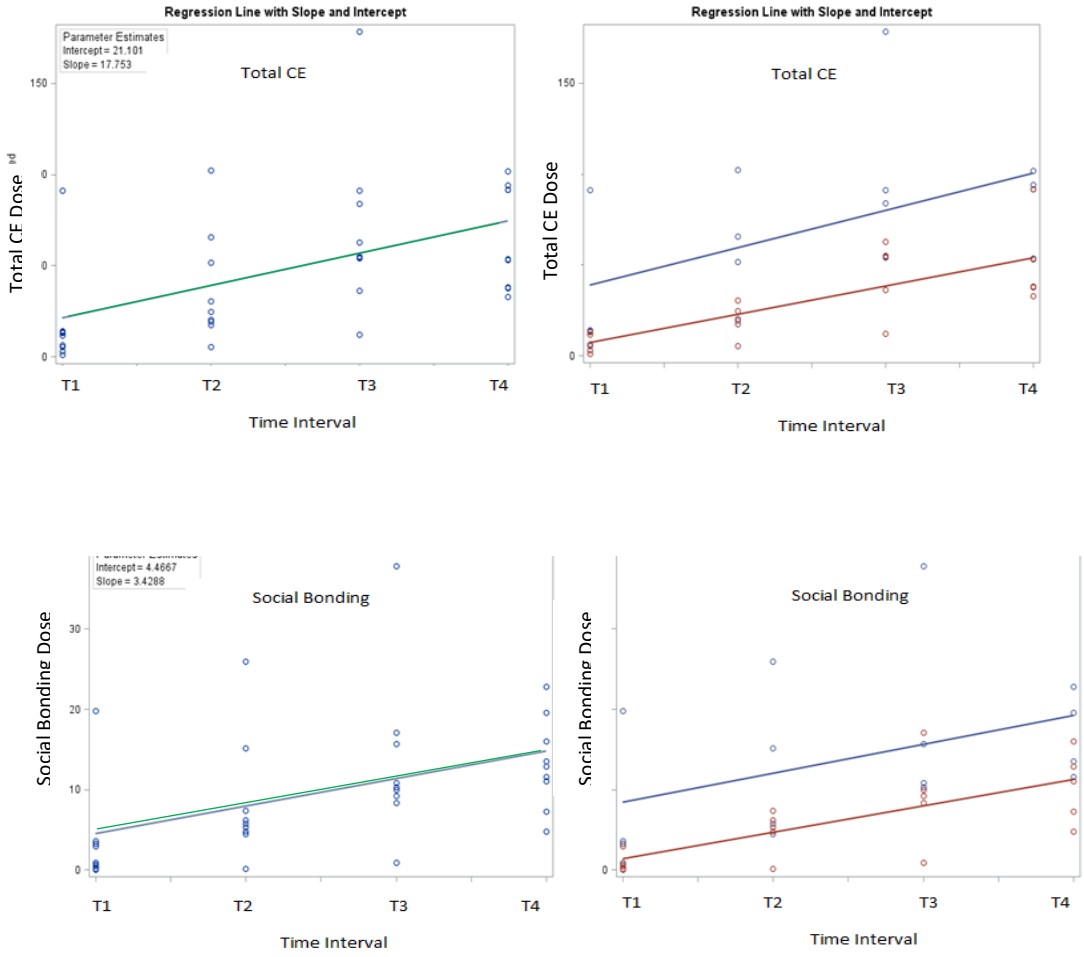
** Borderline significant difference in mean ($p \leq 0.10$)

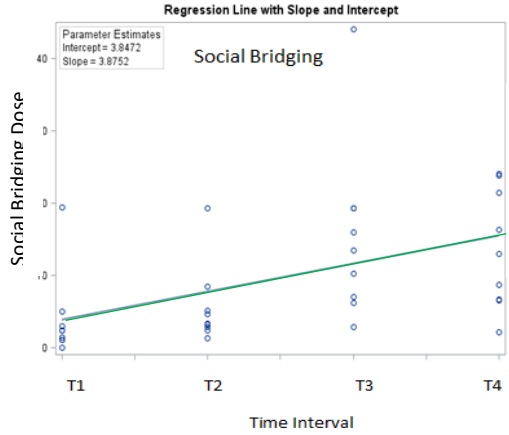
Rate of Increase over Time

To determine if the rate of increase across time intervals was significant, two mixed regression analyses were performed. As shown in figure 4, the sets of slope analysis examines the rate of increase CHL-wide for total CE dose and for each CE building block. The graphs on the left show the combined slope of the CHL communities and the set of graphs on the right compare the rate of increase between the high and low dose groups with the blue line representing the slope for the high dose group and the red line representing the slope for the low dose group.

The CHL-wide mixed regression analysis found a significant increase in all CE doses, intercept 21.1, slope 17.8 ($p<0.001$), with the exception of civic engagement. This assumes a common slope for all communities. Not every community had a significant increase, but in the combined data, the average slopes were significantly different. In the combined data, total CE increased 17.8 units per time period; social bonding increased 3.4 units per time period; social bridging increased 3.9 units per time period; social leveraging increased 5.8 units per time period and empowerment increased 3.1 units per time period. There was no significant increase (1.6 units per time period) in civic engagement dose (Figure 4.4).

When analyzing the rate of increase between the two groups over time, the rate of increase in the high CE dose group was higher than in the low CE dose group for social bridging (by 3.8 units per time period, $p=0.05$) and civic engagement (3.1 unit per time interval, $p=0.01$). No significant difference in rate was seen in any other building blocks or in total CE dose.




Regression Line with Slope and Intercept
Parameter Estimates
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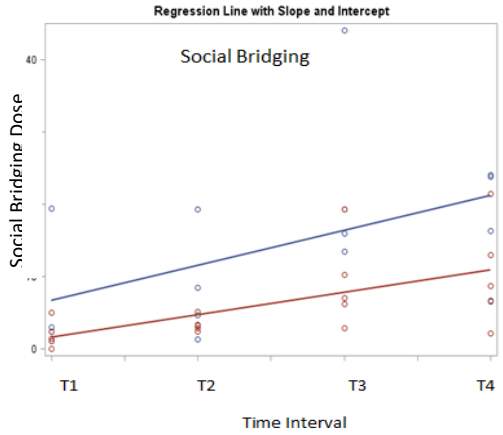
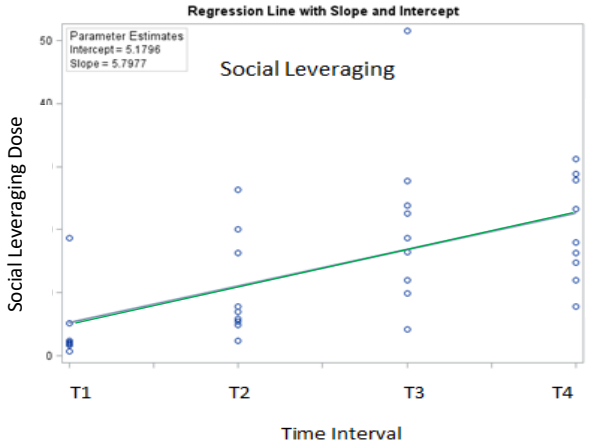
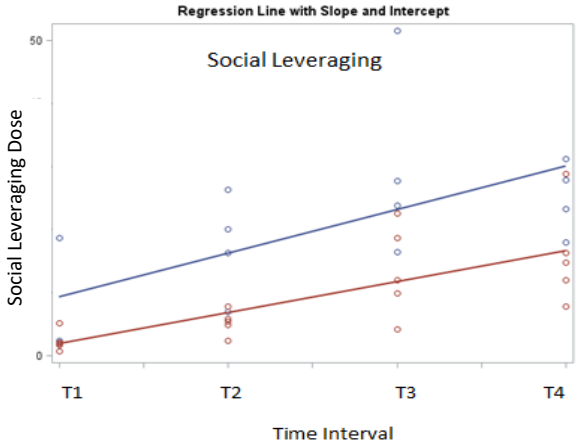
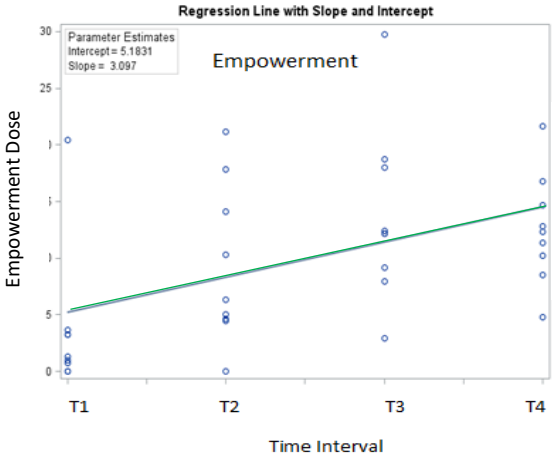
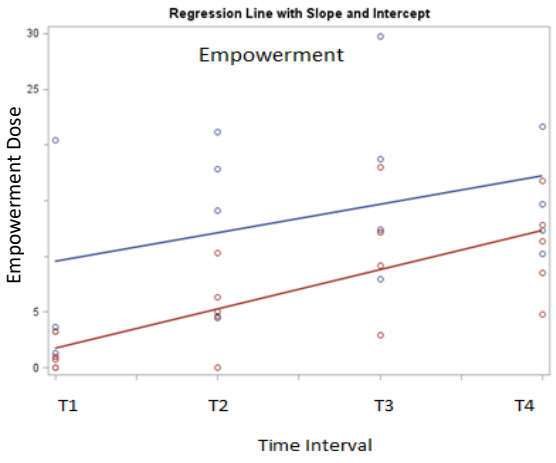
Slope = 3.8752
Social Bridging
Social Bridging Dose
40
0
T1
T2
T3
T4
Time Interval

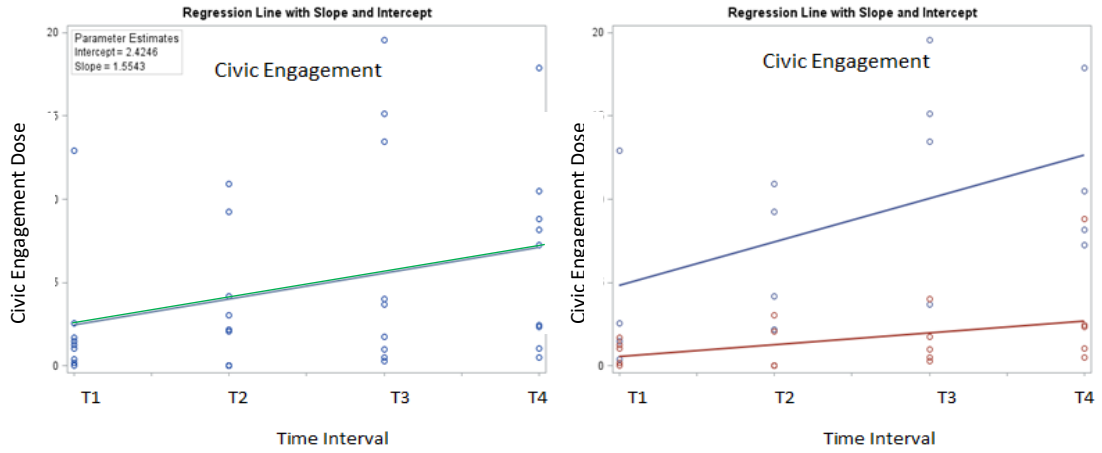

Regression Line with Slope and Intercept
Social Bridging
Social Bridging Dose
40
0
T1
T2
T3
T4
Time Interval


Regression Line with Slope and Intercept
Parameter Estimates
Intercept = 5.1796
Slope = 5.7977
Social Leveraging
Social Leveraging Dose
50
0
T1
T2
T3
T4
Time Interval


Regression Line with Slope and Intercept
Social Leveraging
Social Leveraging Dose
50
0
T1
T2
T3
T4
Time Interval


Regression Line with Slope and Intercept
Parameter Estimates
Intercept = 5.1831
Slope = 3.097
Empowerment
Empowerment Dose
30
25
5
0
T1
T2
T3
T4
Time Interval


Regression Line with Slope and Intercept
Empowerment
Empowerment Dose
30
25
5
0
T1
T2
T3
T4
Time Interval



Green line – Common Slope line for all Communities

Blue line - High-Dose Group

Red line – Low-Dose Group

Figure 4. 4. ***Slope and Intercept over time and between low and high CE dose groups***

Discussion

This cross-case analysis of the CHL intervention had three main findings: 1) communities with higher CE dose realized greater decreases in recreational screen time in their children; 2) CE building blocks worked together synergistically and implementation order was not apparent, and 3) more civic engagement activities were conducted in communities with the greatest decrease in screen time.

CE dose correlated with changes in screen time

In the nine CHL intervention communities, overall CE dose increased over time. This finding was similar to the increase in overall community intervention dose from year one (25.33) to year two (62.57) (Chapter 3). There was a strong negative correlation of total CE dose and change in screen time in young children. Communities with total CE dose of greater than 200 saw the greatest decrease in screen time from baseline to 24 months. Additionally, civic engagement demonstrated a strong negative correlation to change in screen time and there was a significant difference in high and low dose group means. To improve screen times, these results suggest a 200 minimum total CE intervention dose and, due to the significance of civic engagement, a dose of 20 for the civic engagement CE building block (Figure 4.2).

Social leveraging doses (activities that utilized resources outside the community) were highest, and civic engagement doses (policy and community change activities) were lowest among the building blocks in all communities. To ensure sustainability of the CHL intervention, a guiding principle was to "support what was already working in the community" (Braun, Nigg, Fialkowski et al, 2014), which may have been reflected in the social leveraging dose. The resources provided by the CHL grant and the land grant colleges' connections to other agencies may also have impacted the social leveraging doses. Implementing civic engagement activities requires time to develop capacity, social structures, and opportunities for involvement (Collins et al, 2014; Foster-Fishman, Cantillon, Pierce, & Van Egeren, 2007). The need to establish these factors in CHL intervention communities may explain the lower civic engagement doses.

Synergism of CE building blocks

The CE building blocks of social bonding, social bridging, and empowerment activities were similar and consistent throughout the intervention time intervals. It appears activities creating strong connections (social bonding), reaching out to diverse groups in the community (social bridging), and build capacity (empowerment) may be interactive. As social cohesion and the willingness to act or intervene are found within and between individuals, groups, organizations, and policy makers (Alsop, 2005; Beck et al., 2012; Collins et al., 2014; Domínguez & Arford, 2010; Kleinhans & Bolt, 2014), it is not surprising the multilevel CHL intervention saw an interaction between the building blocks.

Even though there was no apparent implementation order of the CE building blocks in the CHL intervention, it is interesting that social bonding and empowerment were correlated to change in screen time at time interval one; and correlation was seen between screen time and social bridging, social leveraging, and civic engagement at time interval three. The differences in means between the high and low dose groups, and in the rate of increase in CE and social bridging doses throughout the intervention, point to differences in type and amount of CE building blocks addressed at the various time intervals across the nine groups and may account for the correlations. The significantly different overall group dose means for empowerment and civic engagement, and the rate of increase in social bridging and civic engagement dose between the two communities suggests the implementation of CE building blocks is nuanced, and the way the building blocks are woven together may influence outcomes. These differences suggest the

sooner communities developed “the willingness to take action,” the greater the decrease in screen time.

Civic engagement was a key building block

Civic engagement appeared to be key in effecting positive change in the CHL intervention, as indicated by the strong relationship to change in screen time and significant differences between high and low communities in the rate of change and means at time intervals two, three, and four. This supports the findings in the literature review by Butel & Braun (2016) that found interventions offering activities to improve civic engagement were more likely to have improved community health compared to interventions that did not attempt to improve civic engagement. Civic engagement activities for this study were defined as activities that guided the community to consciously work toward policy and/or community change. As an example of working towards a policy change, one community worked with preschools to write wellness policies incorporating nutrition and physical activity standards. Another included community efforts to refurbish playgrounds and establish walking paths in communities.

As there was not a significant difference between the doses of the high and low CE intervention dose groups at time interval one suggests civic engagement activities took time (6 months) to develop. Social bonding showed a strong relationship to change in screen time at time interval one, indicating social bonding activities were implemented first. This finding agrees with the literature, Collins (2014) found civic engagement was partially mediated by social capital, in particular social bonding, and those who were more civically engaged reported higher levels of CE. Additionally, the surge in civic engagement at time interval three (12-18 months into the intervention) in the high dose group suggests that the implementation of policy and community change requires adequate time.

Limitations

This study has some limitations. The size of the sample (n=9) limited the types of analyses that are possible. As a result, the analysis was limited to exploratory methods to help clarify the CE building block dose and implementation order. Next, the statements contained in the building block rubric may have been biased by the researcher. To address this, prior literature was used to ensure the statements were grounded in the literature, and a second reviewer was utilized to ensure consistency and reliability. The guiding role of the CHL coordinating center and the mechanism of reporting the activities may have affected the determination of CE dose

resulting in potential in over- or underestimated activity participation. Communities with missing reports could have been conducting activities that did not get counted. Communities also may have interpreted an "activity" very rigidly, and not reported actions done to "prepare" for activities, such as talking to stakeholders and coalitions about activities they could pursue together. Efforts were made to secure missing reports by calling the jurisdictions. The estimated effect of the missing reports on the analysis is minimal as a majority of missing reports were confirmed to have no activities conducted. Additionally, the sustainability of the intervention activities, the long-term effect of the intervention on change in screen time and CE is not known. These findings may not be generalizable to non-Pacific populations.

Conclusion

The CHL intervention wove all five CE building blocks into intervention activities. The simultaneous development of social cohesion through building strong relationships (social bonding) in communities, opening up the community to additional resources (social leveraging), and bringing in different viewpoints (social bridging), along with building capacity (empowerment) and identifying opportunities to act for the common good (civic engagement) may have created connected communities that felt supported in their efforts to address childhood obesity. In addition, implementation of activities that promoted civic engagement were needed to effect change, civic engagement activities need time to implement, and building-in activities that communities can implement may increase impact on outcomes. The results of this study suggest the CE MAM is a framework that may guide community-level intervention to address childhood obesity prevention.

CHAPTER 5. COMMUNITY NETWORKS IN THE IMPLEMENTATION OF COLLECTIVE EFFICACY BUILDING BLOCKS: A CROSS-JURISDICTION ANALYSIS FROM THE CHILDREN'S HEALTHY LIVING PROGRAM

Abstract

Collective efficacy (CE) refers to social cohesion and willingness of a group to act for the common good. Communities with high levels of CE have been shown to be more successful than groups with low levels of CE in implementing complex community interventions to improve health outcomes. Community networks include individuals and groups, and those with strong partnerships and relationships are better situated for implementing community-based interventions. However, information on the types and density of network relationships required for the CE development process is not present in the literature. Using data from the multilevel Children's Healthy Living (CHL) intervention to reduce child obesity in nine Pacific communities, this study aimed to understand how community networks evolved as CHL staff implemented activities to strengthen the five CE building blocks (social bonding, social bridging, social leveraging, empowerment, and civic engagement) to increase CE and reduce childhood obesity.

Implemented activities from CHL data were linked to relevant CE building blocks and coded. To investigate how community networks changed over the course of the intervention, coding was done on six-month "blocks" of activities over the 2-year intervention. The coded data were used to create network maps for the four time intervals. Because the nine communities varied in intervention and CE dose (and correspondingly in success at improving obesity indicators), they were divided into two groups—high dose and low dose—and community network patterns were analyzed. Information on the evolution of social networks in the more successful vs. less successful communities was proposed to help expand the usefulness and applicability of the CE as an intervention focus.

We found that community network density increased over time. For CHL, schools, community-based groups, and large organizations were the primary implementers of this child obesity intervention and, therefore, key members of the network. Partners in high-dose (successful) communities provided more social leveraging activities than did partners in low-dose communities. These findings highlight the need to have sufficient time to develop and build

relationships among school, non-profit, and large organizational partners, especially those that can leverage new resources for the community, to reduce young child obesity.

Introduction

To implement complex community interventions, a "place-based" organizing framework involving collaboration among community-based partners has been recommended (Department of Health and Human Services, 2016), and the literature indicates that the development of community-based coalitions has the potential to lead to better health outcomes (Gibbons & Weiss, 2012; Scanlon et al., 2012). Making positive health changes in low-income communities is a challenging task. These changes require community partners to work together at the local level. Partnerships of diverse organizations that work towards strengthening communities offer opportunities to leverage resources, expand reach, and develop skills to impact the health of communities (Butterfoss, 2007). By working towards a common goal, community coalitions can mobilize resources, coordinate activities, and join together to limit the duplication of activities. In addition, the broad reach of diverse groups offers opportunities to increase public support for policies and community action, creating a potential for larger collective impact (Kendall, Muenchberger, Sunderland, Harris, & Cowan, 2012).

Collaboration and coalitions happen within community networks. Community networks consist of informal relationships between individuals and groups with various relationship strengths and degree of trust between them (Gilchrist, 2009). One way to look at community social networks is through the lens of collective efficacy (CE). CE looks at how different types of relationships work together – some being closer than others.

As defined by Sampson (1997), CE is social cohesion combined with the willingness to act/intervene for the common good. Research suggests that social cohesion and the willingness to act/intervene are affected by the strengthening of five CE building blocks in communities (Collins, Neal & Neal, 2014). The CE building blocks of social bonding, social bridging, and social leveraging make up the social cohesion component of CE; and empowerment and civic engagement are building blocks associated with the willingness to act/intervene (Butel & Braun, 2016). Thus, increasing the community level of the five CE building blocks is a critical step in the process to increase CE, which can then improve health outcome indicators.

According to Larsen (2004), *social bonding* at the neighborhood/community level requires trust and association. Social bonding creates networks with close ties between similar

groups. Bonding occurs when members of the community band together in groups and networks and support their collective needs, for example a neighborhood watch group. *Social bridging* consists of loose ties to socially dissimilar groups. Social bridging networks are based on generalized trust and are reciprocal in nature, (e.g., having a booth at a community event). Social bridging brings in resources, connections, and opportunities (Domínguez & Arford, 2010; Hamidreza Babaei, 2012). *Social leveraging* is the linking of community to people and/or groups in positions of authority and power (Woolcock, 2001). These loose leveraging networks link to groups outside the community, such as government institutions, policy makers, businesses, and funders, which can provide resources to develop capacity and expand services in the community (Hamidreza Babaei, 2012). These bonding, bridging, leveraging networks perform important functions in everyday life and are the building blocks of social cohesion (Forrest & Kearns, 2001).

Together, these social networks are described as the amount and quality of social interactions within communities and between people with similar behavioral norms that allow for mutually beneficial cooperation (Forrest & Kearns, 2001). Social networks can be further defined as "reciprocated exchanges that promote collective efficacy or trust and cohesion among residents combined with expectations for informal social control related action" (Browning, Feinberg, & Dietz, 2004). These can be categorized as low frequency exchanges or high frequency exchanges and can be found in the social cohesion building blocks of social bonding, social bridging, and social leveraging (Domínguez & Arford, 2010). Strong social networks can bring social cohesion to communities, creating a capacity for social action (Frantz, 2016). Social action requires the willingness to act/intervene, the other component of CE. The willingness to act/intervene consists of the CE building blocks of empowerment and civic engagement. *Empowerment* is the building of capacity in social networks and *civic engagement* are activities of a political or civic nature intending to address an issue of common concern (Collins et al, 2014; Cramb, 2006; Forrest & Kearns, 2001; Harknett, 2006; Henly, Danziger, & Offer, 2005; Lin, 2001).

Social networks are found within and between individuals, groups, organizations, and policy makers. Communities are made up of a complex system of social networks consisting of both strong and weak social ties. The CE mechanism of action model (CE MAM, Figure 5.1) shows how intervention activities—like hands-on training, leadership development, peer

mentorship, community events, directed projects, and advocacy—can strengthen the five CE building blocks, which in turn improve overall CE (social cohesion and willingness to act), which in turn can improve community health outcomes (Butel & Braun, 2016). These activities occur at multiple levels.

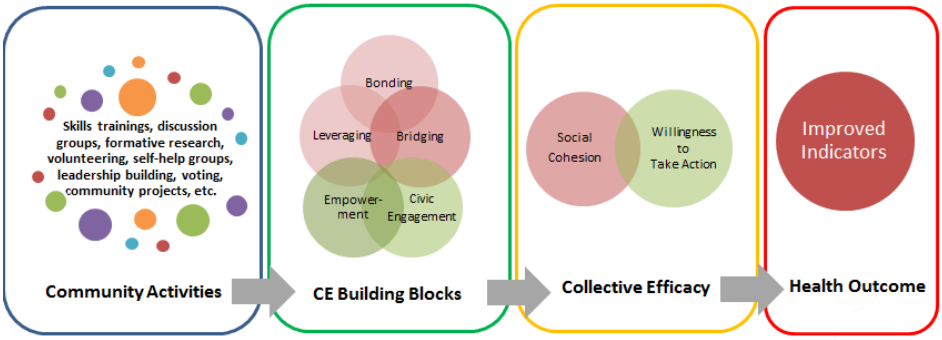


Figure 5. 1. ***Collective Efficacy Mechanism of Action Model (CE MAM)***

The role of collaborations and networks working together is central to CE (Kleinhans & Bolt, 2014). Not understood in the CE MAM is the various types of social networks needed to affect social change. Nor is there a description of the types and density of the network relationships comprising the CE development process in the literature. This study aimed to use social network analysis to explore how communities engaged to reduce child obesity expanded and strengthened its social networks over time.

The Children's Healthy Living program (CHL) was a community-driven multilevel intervention that took place in the U.S. Affiliated Pacific between 2013 and 2015. The CHL intervention effect was tested through a community randomized controlled trial (CRCT) in five jurisdictions where nine communities received the intervention, and nine matched communities served as delayed-intervention controls (Wilken et al., 2013). Institutional Review Board (IRB) approval or ceding of approval to the University of Hawai'i at Mānoa was obtained in each jurisdiction.

The CRCT aimed to evaluate the intervention's impact on anthropometric indicators including body mass index (BMI) and waist circumference, acanthosis nigricans, and six behavioral objectives for children age 2-8 years, including increasing fruit and vegetable intake, water consumption, physical activity, and sleep duration; and reducing recreational screen time, and sugar-sweetened beverage consumption (Wilkens et al, 2013). The intervention had a

preliminary significant positive effect on decreasing acanthosis nigricans, waist circumference, overweight status, and recreational screen time (Novotny et al, 2017).

The CHL intervention worked with community partners to implement activities. Due to the diversity of the various CHL communities, the CHL intervention guided the communities on "what" activities to implement and allowed them to determine specifically "how" to implement them. For example, one required activity was to "work with existing organizations and coalitions and/or form new coalitions to advocate for better access to parks that are safe and inviting". However, it was up to the community to decide exactly how parks could be improved and which resources to leverage. New partnerships were developed among various partners to implement the intervention. Working with partners was central to the CHL intervention.

To explore the networks developed in the CHL intervention, social network mapping was used. Social network mapping is a systems approach to understanding the dynamics of multilevel interventions by drawing attention to the networks of social relationships that make up the system and the variety of roles that exist and can be created within networks (Hawe, Shiell, & Riley, 2009). Theorists have hypothetically used Social Network Analysis (SNA) to look at how interventions transform the structure of community networks by the creation of new events by activity setting (Hawe et al., 2009), and have drawn on prior SNA work in workplace change processes and resource sharing networks (Callon, 1984; Orlikowski & Robey, 1991). SNA with multilevel, community-based interventions is still in the early stages. One study looked at the density of community coalition networks and the uptake of evidence-based interventions (Valente, Chou, & Pentz, 2007). This study used cross-case analysis of the 9 CHL intervention communities to explore community social networks and how they developed over the course of the intervention. Some communities were more successful than others at strengthening the 5 CE building blocks, and some were more successful than others at reducing child obesity indicators. It was hoped that information on the evolution of social networks in the more successful vs. less successful communities would help expand the usefulness and applicability of the CE MAM.

The research question being addressed in this study is: What was the density and pattern of community networks throughout the CHL intervention? It is hypothesized that communities with higher CE intervention dose will demonstrate denser network patterns than those with a lower CE intervention dose.

Methods

The CHL intervention communities were categorized into two groups based on the total CE intervention dose (Butel, 2017). Communities with a total CE intervention dose of greater than 200 were placed in the high CE group (n=4). The low CE group consisted of communities with a total CE intervention dose of less than 200 (n=5). The high CE communities realized a greater decrease in screen time (e.g., television and electronic devices with a screen) compared to low CE communities (Butel, 2017). To understand the community and partner networks used to implement the CHL intervention, three separate social network analyses were used. The first two social network analyses provided insight into the networks that assisted in the implementation of activities. The third social network analysis explored interactions between the CE building blocks. These three social network analyses allowed for the mapping and measuring of community partners who assisted in implementing the CHL intervention. This allowed for the description of the social processes that were central to CHL. The mixed method exploratory analysis approach compared patterns across the two groups. Social network maps of the CE building blocks were examined for similarities and differences in patterns across the CHL communities.

The network map data were developed using a three-step process. *Step One.* The CHL intervention monthly process reports submitted during the intervention phase of the program (January 2013 through December 2014) were examined to identify the community implementers (e.g., community partners, members and groups that the CHL staff worked with to implement the activities). These identified implementers were assigned a nominal code based on their characteristics. An example of the coding system is shown in Table 5.1.

Step Two. Implemented activities were evaluated in chapter three of this dissertation and assigned a CE building block weighted value of 0, 0.25, 0.5, 0.75, or 1 score based on the degree to which the activity addressed each respective building block. CE building block(s) that were assigned a CE building block weighted value of 0.75 or 1 were considered to be "meaningfully addressed" and were given a code of "1". If the score was less than or equal to 0.5 the activity was given a code of "0".

Step Three. To create the network maps, step three consisted of three parts. 1) A table was created with the CE building blocks as columns and the community implementers as rows for each activity. Network mapping nodes were generated from the CE building blocks and the

community implementers. 2) A two-mode network map (bipartite map) examined the ties occurring between the CE building blocks and the community implementers. Gephi, an open-source network mapping visualization software (Bastian, Heymann, & Jacomy, 2009), was used to create a bipartite network map for each community group for the four six-month intervals. 3) Additional unimodal maps, maps examining ties existing between a set of nodes, were created to look at relationships between community partners and CE building blocks. The node sizes were based on the number of community implementers in the coded category, and the thickness of edges (lines) were determined by the number of times assistance was given to implement the activity related to CE building block.

Table 5. 1. ***Community Implementer Types, Definitions, and Assigned Code***

Community Implementer	Code
Churches: places of worship and/or clergy (e.g., priest, minister, Catholic church)	1
Community groups: nonprofit groups that work at a local level (e.g., community-based organizations)	2
Role Models: Community members who received CHL role model training	3
Large organizations: Entities outside the community that employ over 50 people (e.g., colleges, departments of health)	4
Preschools/Schools: Institutions for educating children	5
Elected: Individuals or groups who hold public office (e.g., mayors, community/neighborhood boards)	6
Coalitions: Group of people and organizations who join together for a common cause (e.g., Non-communicable Disease Coalition)	7
Cooperative Extension: Land grant college agents who educate communities in a variety of family, health, and agricultural programs (referred to as “extension”)	8

Data were sorted into four intervention time intervals: the first six months of the intervention (0 to 6 months (T1), 6 to 12 months (T2), 12 to 18 months (T3) and 18 to 24 months (T4). A bipartite map was generated for the four communities that demonstrated a high dose of CE and a bipartite map was generated for the five communities that demonstrated a low dose of CE, for each time interval. Thus, a total of eight bipartite maps were generated. Bipartite network

maps characterized the community networks that helped to implement the CHL intervention in terms of nodes (community implementers) and their link to the CE building blocks. The networks were interpreted through visualizing maps that were compared to look for patterns of relationships of community implementers to the CE building blocks between communities. Descriptive statistics of the number of nodes and edges present in the map were reported along with the graph density (number of ties in the network as a proportion of total possible) and the average weighted degree (how much of the implementation was due to implementer code) were calculated for each map.

Each bipartite map generated two undirected (bidirectional connections between nodes) network maps: 1) identified relationships between implementing groups and; 2) identified relationships between the CE building blocks. A total of 16 unimodal, undirected maps were generated. The font size of the text reflects the average weighted degree between community implementers. Thickness of lines is based on the number of times the community implementers assisted in implementation of the same building blocks. In the maps, the weight of each edge was "1" and the weights of each edge were summed. The average weighted degree was the average of sum of weights of the edges of nodes. This was used to identify those groups most central to implementing CE building blocks in the CHL intervention and the edge weight was used to identify how closely groups worked together.

The second map used the same descriptive statistics to identify the most central CE building blocks in the CHL intervention and CE building block clusters. The font size of the text reflects the average weighted degree between CE building blocks. Thickness of lines is based on the number of times the same building blocks were addressed by community implementers. Comparisons were made between groups and over time to determine what networks were present in CHL communities as the CHL intervention was implemented. Differences in graph density (number of ties in the network as a proportion of the total number of ties) (Robins, 2015), edge weights (number of connections between nodes), and average weighted degree between the nodes of the two groups were examined at six-month intervals for the duration of the intervention.

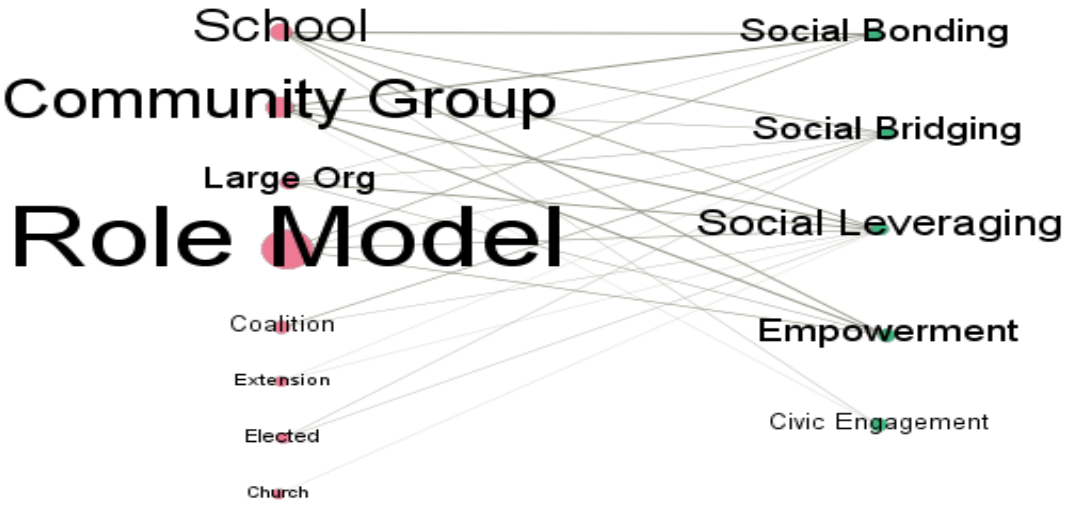
Results

Community implementers' relationship to CE building blocks

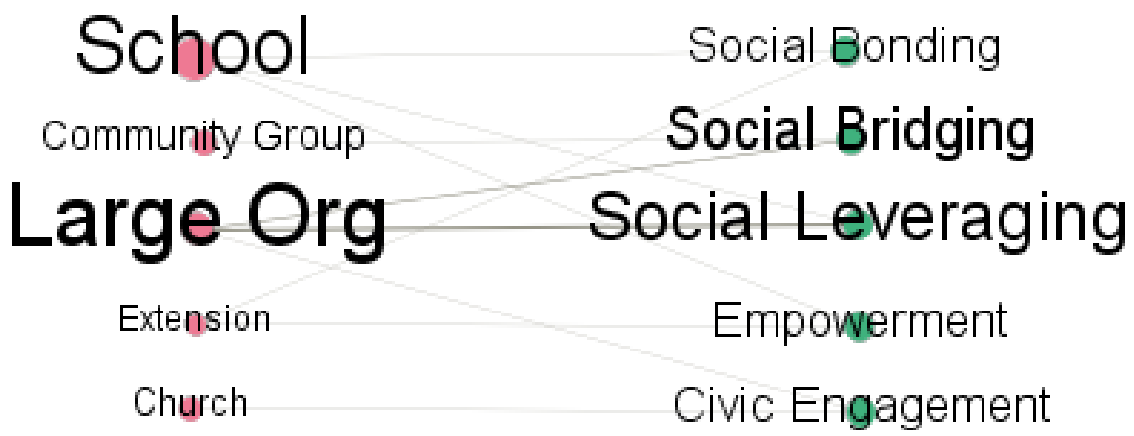
The bipartite maps provide a visual indication of the community implementers shown on the left of each set of maps and their relationship to each of the CE building blocks shown on the right side of each (Figure 5.2). The size of the circle ranks the community implementers based on the number of times they assisted in activity implementation. The font size of the text reflects the average weighted degree for both community implementers and CE building blocks. Thickness of lines is based on the number of times the community implementer contributed to the implementation of activities related to that building block. The maps show the progression of implementation over time and differences between the high and low dose groups.

Table 5.2, displays the descriptive statistics of graph density and average weighted degree by group and time. The graph density increased in the high dose group over time with the largest increase seen between T2 and T3. The low dose group's graph density increased between T1 and T2, remained the same between T2 and T3 and then increased between T3 and T4. The average weighted degree increased for both groups between T1, T2, and T3 intervals. Both groups realized a slight decrease between T3 and T4. The high dose group's graph density and average weighted degree was higher than the low dose group for all time intervals with the only exception being the graph density at time interval T2.

High Dose Group T1

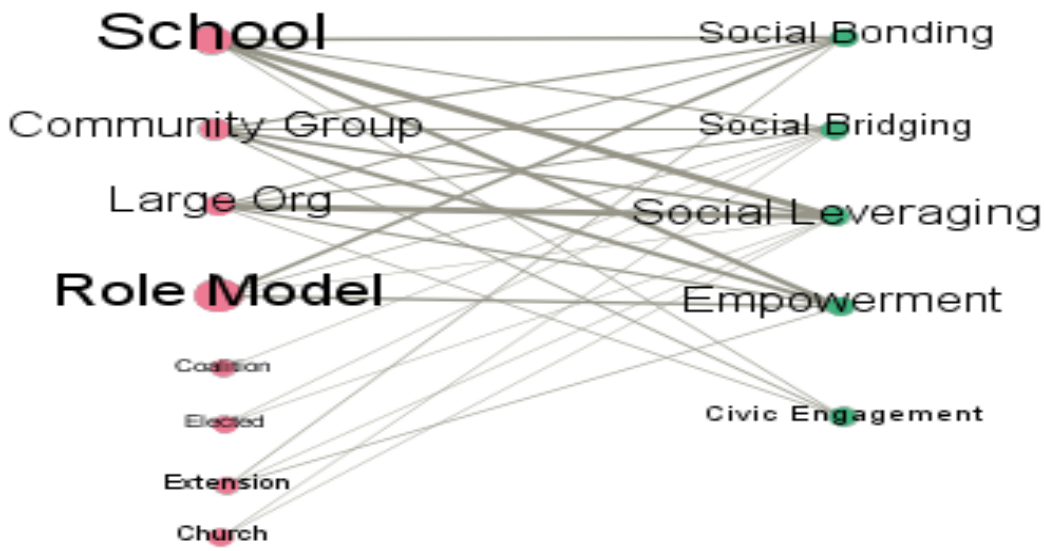


Low Dose Group T1*

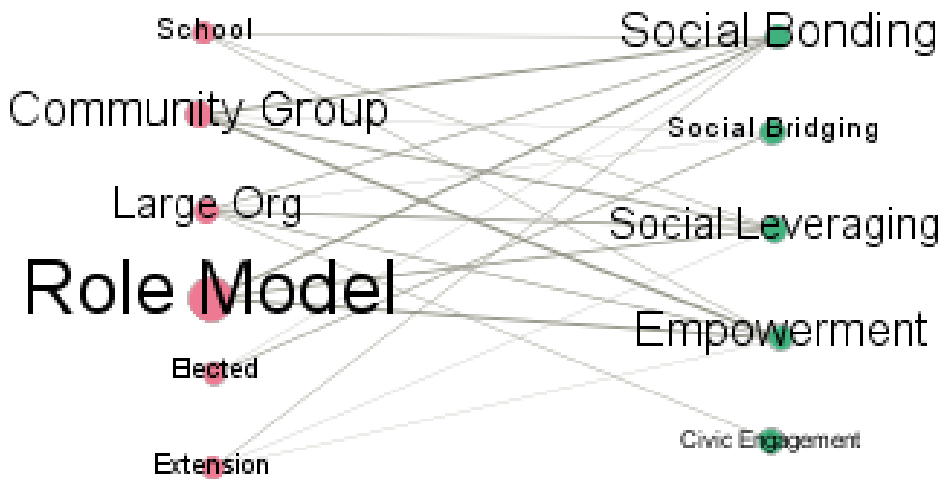


*Role models, elected officials, and coalitions are not on the map as they did not assist in implementing CE building block activities for the low dose group at time interval one.

High Doses Group T2

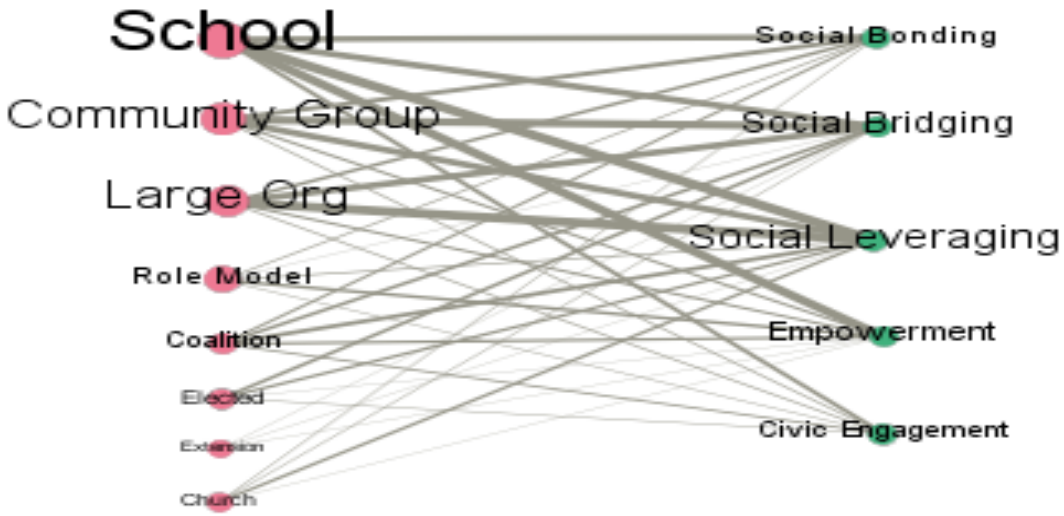


Low Dose Group T2*

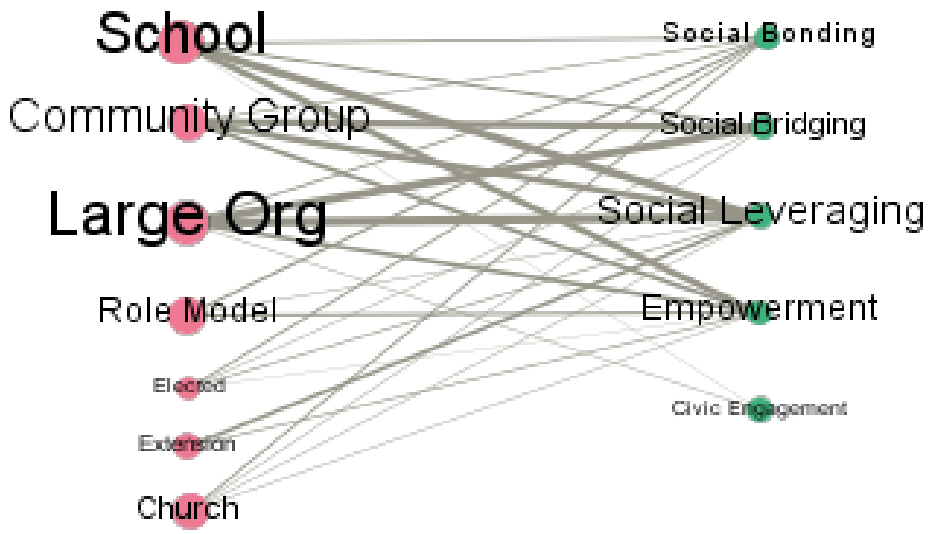


*Churches, and coalitions are not on the map as they did not assist in implementing CE building block activities for the low dose group at time interval two.

High Dose Group T3

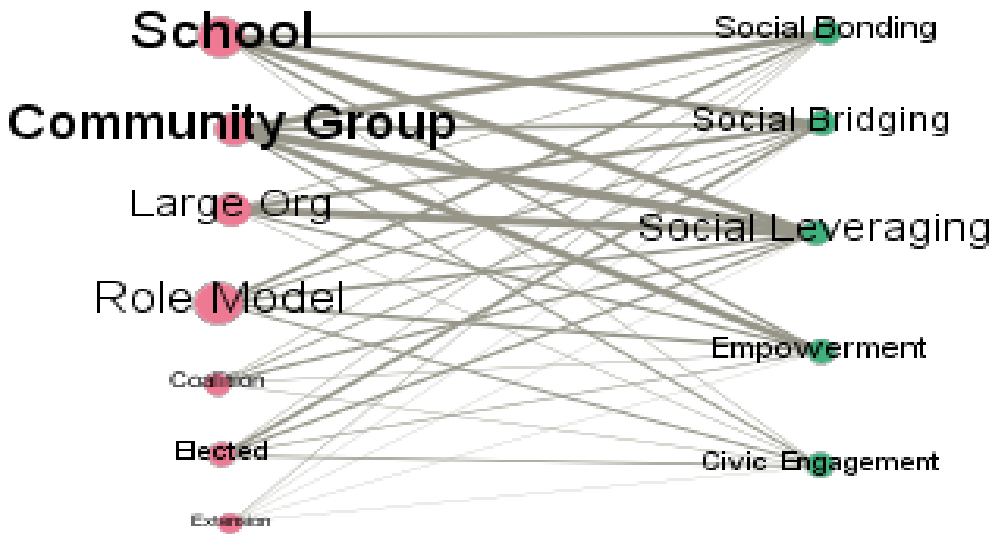


Low Dose Group T3*



*Coalitions are not on the map as they did not assist in implementing CE building block activities for the low dose group at time interval three.

High Dose Group T4*



*Churches are not on the map as they did not assist in implementing CE building block activities for the high dose group at time interval four.

Low Dose Group T4

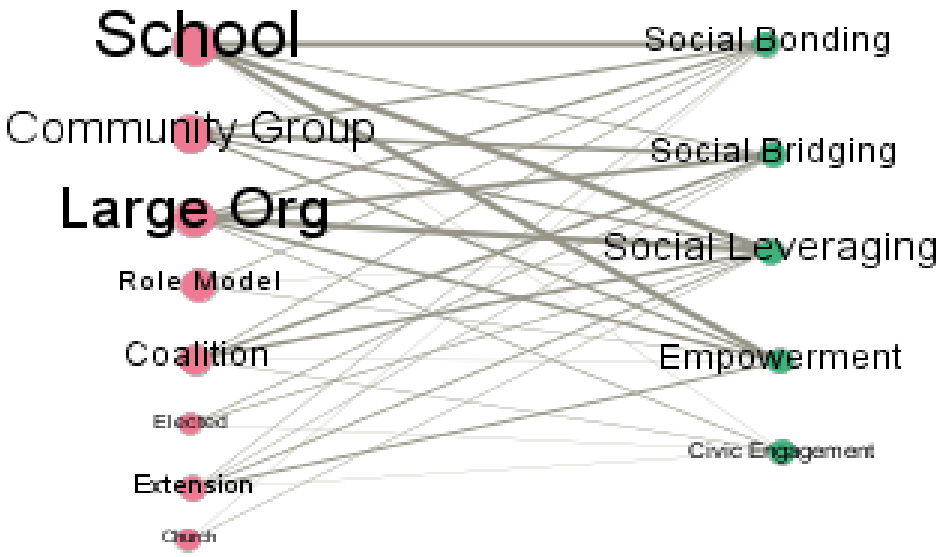


Figure 5. 2. ***Bipartite Maps by High and Low Intervention Dose Groups at four time points***

Table 5. 2. ***Bipartite Network Density and Average Weighted Degree by Group and Time***

	Time Interval 1		Time Interval 2		Time Interval 3		Time Interval 4	
	High	Low	High	Low	High	Low	High	Low
Graph Density	0.3	0.2	0.4	0.4	0.5	0.4	0.5	0.4
Average Weighted Degree	14.0	3.4	22.6	10.4	38.2	24.6	36.7	23.5

The number of times each type of community implementer assisted with an activity was tabulated. The total count for each type of community implementer was then summed by high and low dose group. Overall, the high dose group community implementers assisted 1.9 times more frequently in total CE activities compared to the community implementers in the low dose

group. Overall, the primary implementers among both groups were community groups, large organizations, and schools. In the high dose group, schools most frequently assisted in total CE activities (n=185). Large organizations assisted most frequently (n=105) in the low dose group (Figure 5.3). Community groups, role models, schools, elected, and coalitions assisted over two times more in the high dose group as in the low dose group and large organizations assisted 1.3 times more often in the high dose group compared to the low dose group. Assistance by churches in implementation was similar for both groups but was the lowest community implementer for both groups. Cooperative extension assisted 1.5 times more often in the low dose group than the high dose group.

Figure 5.4 examines the distribution by percentage of assistance across community implementers for each CE building block. Community groups, large organizations, and schools had the largest percentage of activities for social bridging and leveraging among both groups. Empowerment had similar top three implementers. Social bonding also had the same three community implementers (community groups, large organizations, and schools), but role models contributed at the same (low dose group) or greater level (high dose group) as large organizations. Among the top three community implementers (community groups, large organizations and schools) large organizations were utilized more in the low dose group compared to the high dose group and community groups and schools were utilized more in the high dose group compared to the low dose group.

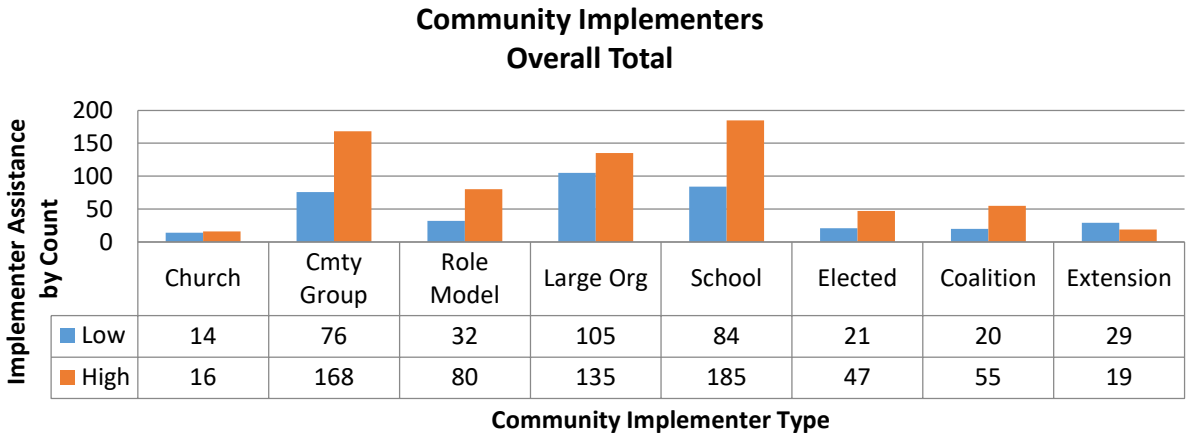
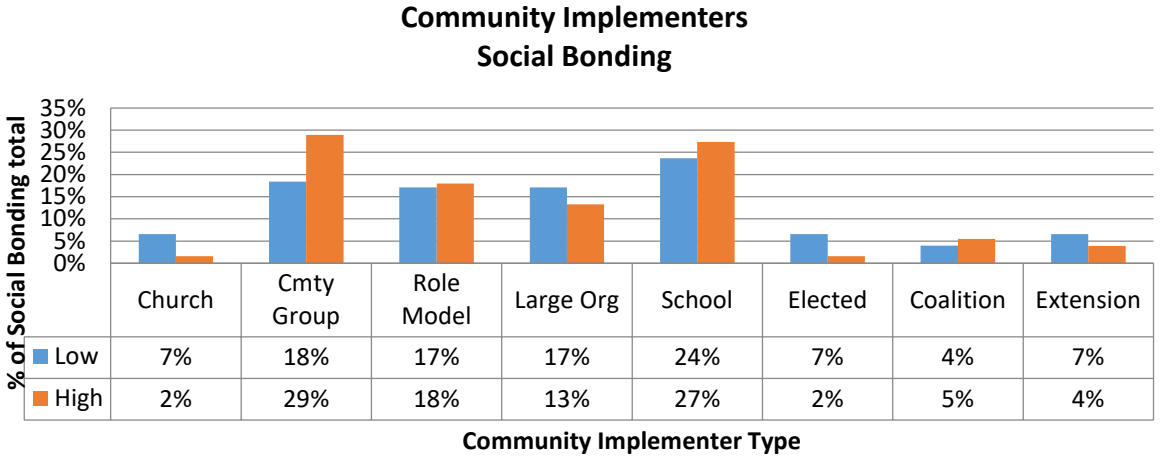


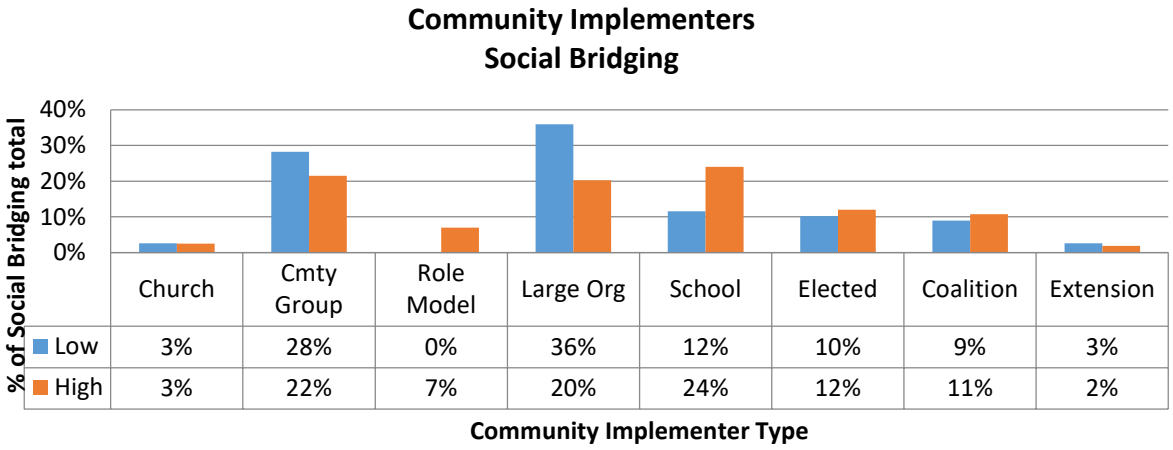
Figure 5. 3. ***Community Implementers by High/Low Dose Group and CE Building Block***

Notable differences were seen in the distribution of community implementers in civic engagement activities. Over 50% of civic engagement activities were assisted by large

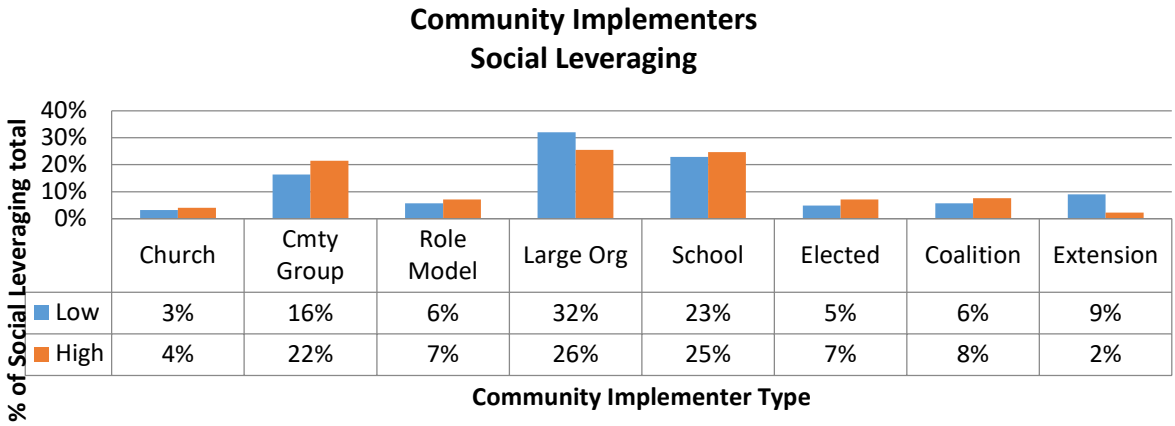
organizations in the low dose group with schools and coalitions each assisting 13%. The percentage of assistance in the high dose group was more distributed across implementers. Community groups and schools (23% and 27%, respectively) led the way, followed by role models (13%), large organizations (17%), elected (11%) and coalitions (11%). Community groups and role models did not assist in civic engagement activities in the low dose group, but combined accounted for 39% of civic engagement activities in the high dose group.

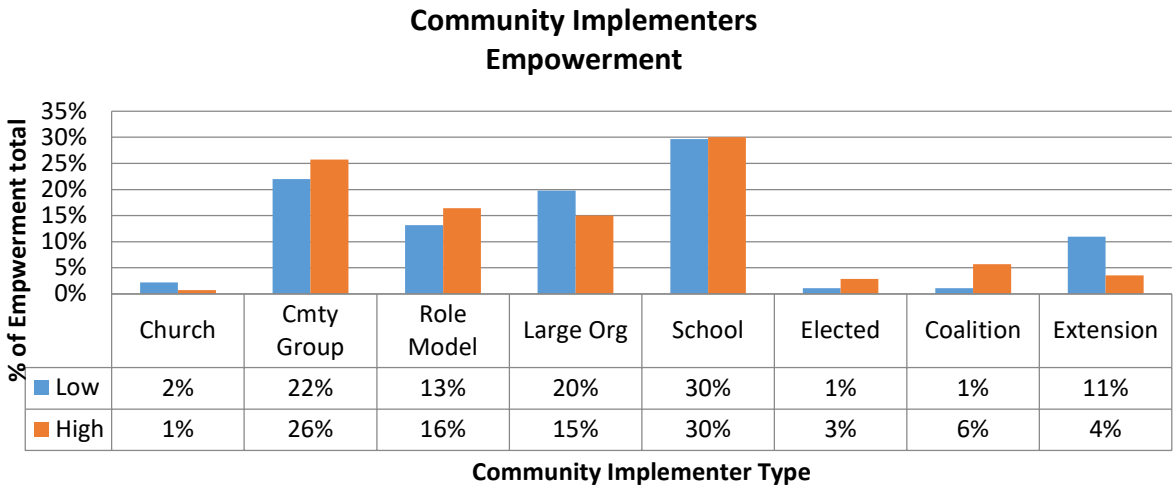


	Church	Cmty Group	Role Model	Large Org	School	Elected	Coalition	Extension
Low	7%	18%	17%	17%	24%	7%	4%	7%
High	2%	29%	18%	13%	27%	2%	5%	4%



	Church	Cmty Group	Role Model	Large Org	School	Elected	Coalition	Extension
Low	3%	28%	0%	36%	12%	10%	9%	3%
High	3%	22%	7%	20%	24%	12%	11%	2%





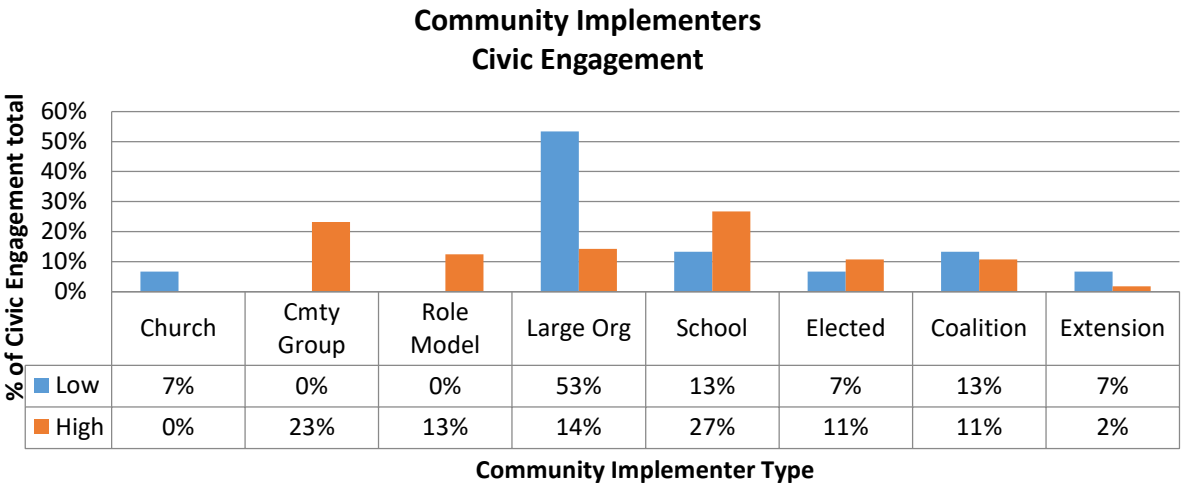


Figure 5. 4. Percent of Community Implementers by CE Building Blocks

Relationships between community implementers

The unimodal maps provide a visual indication of the relationships between community implementers (Figure 5.5). The maps show the progression of the relationships over time and differences in community implementer relationships between the high and low dose groups. There is a pronounced difference in patterns between the groups, with the high dose group having more connections to each other in all time intervals when compared to the low dose group. During T1 the high dose group formed a more interconnected pattern, with the low dose group showing a loosely connected pattern. Community implementers in the high dose group were more interconnected throughout all time intervals when compared to the low dose group.

The edge weight (number of connections between nodes) between community implementers was more pronounced in the high dose group compared to the low dose group for all time periods. Large organizations, schools and community based groups formed a strong triad at T2 for the high dose group and continued to grow at T3 and T4 intervals. The low dose group saw the same triad (large organizations, schools and community based groups develop) at T3 and T4. Graph density of the maps reached one (indicating the maximum number of ties possible for the network) during T2 for the low dose group and at T3 for the high dose group. The average weighted degree increased during T1, T2, and T3 with both groups having a slight decrease during T4. The high dose group's average weighted degree (how much of the implementation was due to implementer code) was higher than the low dose group for all time intervals (Table 5.3).

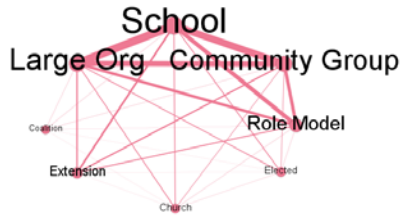
Table 5. 3. ***Community Implementer Graph Density and Average Weighted Degree by Group and Time***

	Time Interval 1		Time Interval 2		Time Interval 3		Time Interval 4	
	High	Low	High	Low	High	Low	High	Low
Graph Density	0.3	0.4	1.0	1.0	1.0	1.0	1.0	1.0
Average Weighted Degree	194.5	4.8	486.0	109.3	1420.3	746.6	1255.1	544.8

High Dose Group – T1

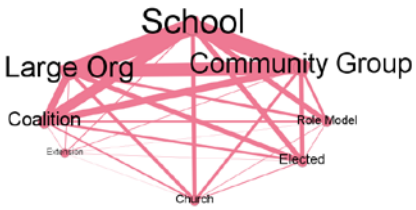
Low Dose Group – T1

High Dose Group – T2

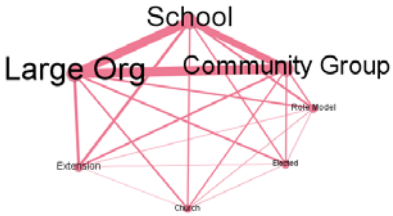


Low Dose Group – T2

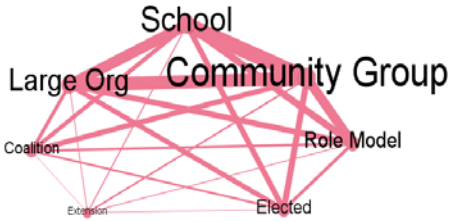
High Dose Group – T3



Low Dose Group – T3



High Dose Group – T4



Low Dose Group – T4

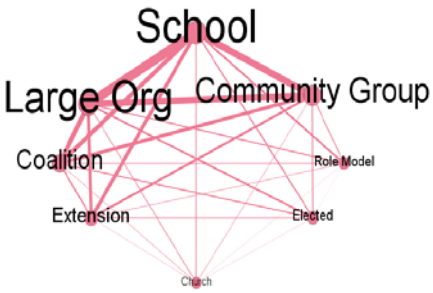


Figure 5. 5. ***Unimodal Map of Relationship between Community Implementers***

Interactions between CE building blocks

The unimodal maps provide a visual indication of the interactions between CE building blocks (Figure 5.6). The maps show the progression of the interactions between CE building blocks over time and differences in the interactions between the high and low dose groups.

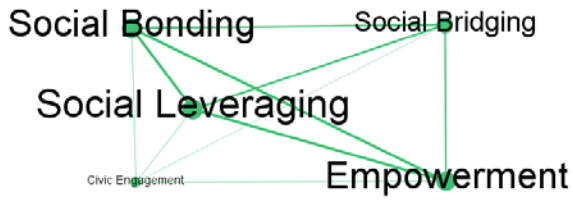
CE building block unimodal maps showed social leveraging was implemented concurrently the other building blocks most frequently, for all time intervals for both groups (Figure 6). Civic engagement interacted the least among the CE building blocks. The maximum number of ties (each node is connected to all other nodes; graph density =1) between all building blocks was seen at all time intervals for the high dose group and for T2, T3, and T4 for the low dose group. The average weighted degree increased during T1, T2, and T3, with both groups having a slight decrease during T4. The high dose group's average weighted degree of connections was higher than the low dose group at all time intervals (Table 5.4).

Table 5. 4. ***CE Building Block Network Density and Average Weighted Degree by Group and Time***

	Time Interval 1		Time Interval 2		Time Interval 3		Time Interval 4	
	High	Low	High	Low	High	Low	High	Low
Graph Density	1.0	0.6	1.0	1.0	1.0	1.0	1.0	1.0
Average Weighted Degree	252.4	12.4	667.2	95.6	1773.2	722.8	1352.0	643.6

Significant differences ($p < 0.05$) in edge weight (number of connections between nodes) group means was found at all time intervals. Social leveraging edge weight group mean was significant at all time intervals. Social bridging and empowerment means were significant at T1, empowerment mean was significant at T2, social bridging and civic engagement edge weight means were significant at T3 and T4 (Table 5.5).

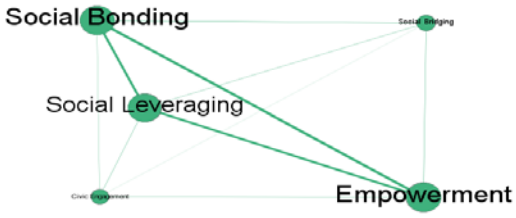
High Dose Group – T1



Low Dose Group – T1

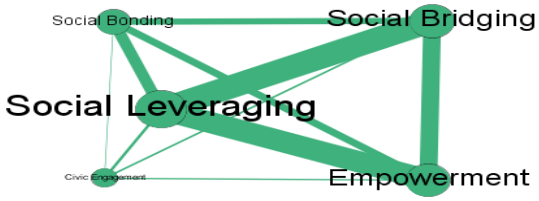
High Dose Group – T2

Low Dose Group – T2

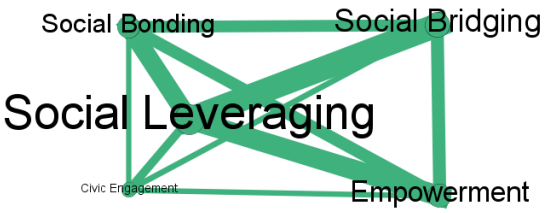


High Dose Group – T3

Low Dose Group – T3



High Dose Group – T4



Low Dose Group – T4

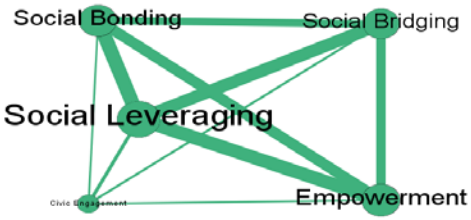


Figure 5. 6. ***Unimodal Map of Interactions between Building Blocks***

Table 5. 5. ***Difference in Group Means for CE Building Block Edge Weights***

	Group mean (s.d.)		p-value
	High	Low	
Time Interval 1 (0-6 months)			
Social Bonding	5.0 (5.1)	0.4 (0.9)	0.08
Social Bridging	5.0 (2.4)	1.0 (1.2)	0.01*
Social Leveraging	7.0 (3.9)	1.4 (0.9)	0.03*
Empowerment	5.3 (3.9)	0.4 (0.9)	0.04*
Civic Engagement	6.8 (1.0)	0.4 (0.5)	0.25
Time Interval 2 (6-12 months)			
Social Bonding	7.5 (4.4)	3.8 (2.3)	0.08
Social Bridging	6.0 (4.7)	0.8 (0.8)	0.06
Social Leveraging	11.3 (5.6)	3.0 (2.1)	0.01*
Empowerment	9.5 (4.1)	4.0 (2.3)	0.02*
Civic Engagement	3.5 (4.0)	1.0 (1.7)	0.12
Time Interval 3 (12-18 months)			
Social Bonding	10.5 (4.7)	4.6 (2.4)	0.02
Social Bridging	16.0 (2.4)	7.6 (4.3)	0.01*
Social Leveraging	21.0 (7.3)	12.6 (4.3)	0.03*
Empowerment	11.8 (4.6)	8.4 (3.2)	0.12
Civic Engagement	5.8 (3.8)	0.6 (0.9)	0.03*
Time Interval 4 (18-24 months)			
Social Bonding	9.5 (3.7)	6.6 (3.9)	0.15
Social Bridging	12.8 (5.3)	6.2 (3.6)	0.03*
Social Leveraging	17.8 (5.9)	10.2 (3.8)	0.03*
Empowerment	10.0 (3.9)	7.6 (3.4)	0.18
Civic Engagement	5.3 (1.7)	2.0 (2.2)	0.03*

Discussion

This study explored three different relationships: 1) activity engagement of different types of community implementers and their connection to the various CE building blocks; 2)

relationships between community implementers, and 3) interactions between CE building blocks. The first two relationship analyses provided insight into the networks that assisted in the implementation of activities. The third relationship analysis explored interactions between the CE building blocks.

Connections between community implementers and CE building blocks

This exploratory social network analysis of the CHL intervention communities had three main findings: 1) A minimum of six months (time period 1) was required to develop and engage community implementers; 2) communities that had a total CE dose of greater than 200 (high dose group) had developed stronger community networks; and 3) more community-based efforts were made in high CE dose communities.

The CHL intervention required time to engage community partners. As the intervention progressed over time more community partners became engaged and increased implementation of activities. The increase in graph density and average weighted degree indicate that relationships were forming during the first time interval (T1) and progressed through the subsequent time intervals for both groups. This follows the "forming–storming–norming–performing" model of group development (Tuckman, 1965). In time interval T1 the graph density and the average weighted degree were low indicating that the relationships were still forming and the roles of the partners was being determined. As time progressed, the relationships developed, became more empowered, and civic engagement activities increased. These findings indicate a six month time period was needed to engage community implementers in CHL intervention activities.

The hypothesis that communities with higher total CE intervention dose would have more networks compared to communities with lower intervention dose was proven in the social network analysis. Although both the high scoring and low scoring groups received assistance from the same types of community implementers, the high dose group's community implementers assisted more often with CHL intervention activities, and assisted earlier in the intervention. Based on graph density and map patterns the low dose group appeared to be one to two time intervals behind the high dose group. These findings indicate that the high dose group developed stronger and more engaged community networks.

The third finding showed assistance levels of community implementers differed between the high scoring and low scoring groups. The greater proportion of assistance by large

organizations in the low dose group compared to the greater proportion of community-based groups and role models in the high dose group suggests that the high dose group communities focused on more grassroots organizations. The assistance by community-based groups, role models, and community boards/elected officials in implementing activities was notably larger in the high dose group compared to the low dose group, especially in civic engagement activities. This observation of community-based groups being the predominant implementers in communities that realized greatest decreases in screen time aligns with other literature findings that development of community-based groups has the potential to lead to better health outcomes (Gibbons & Weiss, 2012; Scanlon et al., 2012).

Relationships between community implementers

The key findings from examining the relationships between the community implementers were the strengthening of community networks and an emergence of a community implementer backbone as the CHL intervention progressed. As shown by the edge weights over the time intervals, the relationships between community implementers (Figure 5) and the strength of connections between the community implementers increased over time. An edge weight pattern emerged between large organizations, community groups, and schools in both groups suggesting a strong relationship between these types of community implementers. This could be the result of the substantial implementation assistance by the three community implementers in the CHL intervention. These three implementer types (large organizations, community groups, and schools) represent multiple levels of influence. For example: large organizations provided skills development training, community-based groups provided cultural context and community structures, and schools provided community-based location and access to the target population (2-8 year olds). This triad formed the backbone for the multifaceted network that emerged in the CHL intervention communities. This supports the recommendation by the U.S. Department of Health and Human Services (2016) to involve a collaboration of community-based partners in the implementation of complex community interventions and the concept that cross-sector efforts need to be aligned, the community engaged, and to have a multifactorial approach to effect community change (Sandel et al., 2016).

Relationships between CE building blocks

As the CE building blocks work together to increase overall achievement of CE (Browning, Feinberg, & Dietz, 2004) it is not surprising that the maximum amount of

connections between the CE building blocks was realized early in the intervention. A finding of interest is the central role of social leveraging in the CHL intervention. The strong relationship (edge weights) to the other building blocks, including civic engagement, suggests that social leveraging resources such as providing skills training and building on activities of similar programs was central to: the development of community trust e.g., providing playground painting supplies (social bonding); establishing connections between community implementers example e.g., local non-profit bringing program to HeadStart classrooms (social bridging); building community capacity e.g., training families and teachers how to grow food (empowerment); and providing opportunities for civic engagement e.g., getting permission from park department and officials to improve park facilities. Sandel et al (2016) found that supporting capacity development, merging multiple funding streams, and investment of resources in underserved communities are needed to have successful community-level interventions. The CHL program, which was based at the land grant colleges, provided resources and served as a backbone organization to the CHL intervention communities and may have influenced the role of social leveraging. However, a variety of community implementers assisted in social leveraging activities. This indicates involvement by community partners and a collaborative implementation of the CHL intervention.

There was a slight decrease in activities during the last time interval (T4). During the last six months of the intervention, new implementation efforts were not promoted, as one of the goals of the CHL intervention was sustainability. The CHL program sought to implement activities that could be continued after the intervention period and the last six months focused more on supporting ongoing community efforts.

Limitations

This study had identifiable limitations. First, the retrospective nature of this study limited the ability to obtain clarity when questions arose regarding community implementers. The systematic method of submitting the reports, along with other supporting CHL documents, were relied on when questions arose. Second, the CE building blocks were binary coded (yes/no), as to whether or not they were addressed. This did not allow for the nuances of interactions between the building blocks to be identified. However, the coding procedure identified major interactions between the CE building blocks. The size of the sample (n=9) limited the types of possible analysis and thus, the conclusions that were drawn. As a result, the analysis was limited to

exploratory methods to help clarify the social networks that were present in the CHL intervention.

Conclusion

The cross-case analysis of the CHL intervention allowed for the exploration of relationships needed to activate the CE MAM and social network mapping provided a way to visualize community connections. Comparing the community networks over time highlighted that the CHL intervention communities required sufficient time to develop relationships amongst partners and to build relationships with multiple types of community implementers with a focus on schools, community-based organizations and large organizations. Additional studies of social networks in CE interventions that explore interactions between community implementers and CE building blocks are needed to identify key points that can leverage community action.

CHAPTER 6. WHAT SUPPORTS AND HINDERS COMMUNITY INTERVENTION SUCCESS? A CROSS-CASE STUDY OF THE CHILDREN'S HEALTHY LIVING (CHL) PROGRAM TO REDUCE CHILDHOOD OBESITY

Abstract

Multisite studies are useful in testing generalizability of community-level interventions, recognizing the need for interventions to be tailored to fit local context. Collective efficacy (CE), defined as willingness and ability to work towards a common good, is suggested to tailor and implement community-level interventions. As outlined in the CE Mechanism of Action Model (CE MAM), CE is strengthened through intervention strategies promoting the five CE building blocks—social bonding, social bridging, social leveraging, empowerment, and civic engagement. However, little is known about barriers and supports to tailoring and implementing multisite, community interventions.

Using the CE MAM framework, monthly reports from the nine intervention sites participating in the multilevel Children's Healthy Living (CHL) intervention to reduce childhood obesity in the U.S. Affiliated Pacific were coded for themes related to implementation supports and barriers. Four communities exhibited greater success, as indicated by higher intervention dose, and reduced screen time in children. Thus, themes were compared between the four high-dose and five low-dose communities. Across communities, delays in tailoring and implementation were primary barriers to success. However, high-dose communities had three times as many civic engagement codes and twice as many social bonding codes as low-dose communities.

These findings suggest that community-level interventions should include activities that promote social bonding and civic engagement, as they appear to help build CE to tailor and implement the intervention. A measure of pre-existing CE might be useful to understand potential barriers and supports when tailoring interventions, as we expect community acceptable activities that strengthen CE will more likely be implemented.

Introduction

To achieve substantial and sustained change; developing, implementing and evaluating multilevel interventions is needed (Cleary et al., 2012). However, the complexity and expense of developing and implementing multilevel interventions in multiple settings limits studies from being conducted (Cleary et al, 2012). The National Heart, Lung, and Blood Institute, challenged

experts to examine solution-oriented approaches that address "what works, how and to whom" (National Heart, Lung, and Blood Institute, 2015). The institute sought holistic interventions that consider interactions and feedback loops along with models to understand the complexities in multilevel interventions (National Heart, Lung, and Blood Institute, 2015).

The research in multilevel interventions lacks a unifying theory and tends to use the ecological model to communicate and conceptualize interventions (Clauser et al, 2012). Capturing the mechanisms (to include barriers and local adaptations) of implementing community-based interventions is inherently difficult due to the lack of consensus on how to conceptualize and operationalize intervention exposure (Richards et al, 2014). Additionally, interventionists need to embrace the way a community wants to address issues, and at the same time, adhere to proven theories and frameworks. Making the two approaches fit requires flexibility and the ability to work effectively with communities.

Tailoring strategies to meet community culture and needs requires intervention implementation staff to be responsive to community solutions and to implement evidence-based activities (Cohen et al., 2008). Providing a framework to implement intervention activities allows for community-based interventions to balance fit and fidelity. However, the complexity of tracking and analyzing data to identify implementation strategies and adaptations is challenging as interventions differ (Clauser et al, 2012; Richards et at, 2014).

Collective efficacy (CE), defined as social cohesion combined with the willingness to act/intervene (Sampson, Radenbush, & Earls, 1997), has broad application to community-level interventions. The building blocks of collective efficacy include cohesion between similar groups (social bonding), ability to work with diverse groups (social bridging), leveraging resources (social leveraging), ability (empowerment) and willingness to participate in policy and community change (civic engagement) (Collins, Neal, & Neal, 2014); these building blocks are inherently interactive and multilevel. Identifying strategies and techniques to implement activities is difficult (Butel & Braun, 2016; Egan et al, 2008). The CE MAM (Figure 6.1) (Butel & Braun, 2016) provides a framework to operationalize CE. To expand the usefulness and applicability of this model, knowledge on how to implement activities is needed.

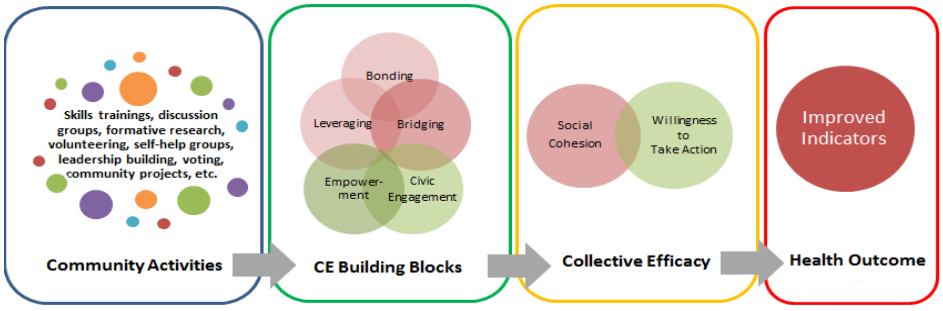


Figure 6. 1. ***Collective Efficacy Mechanism of Action Model (CE MAM)***

The Children's Healthy Living (CHL) program, a USDA Agriculture and Food Research Initiative, addressed the growing prevalence of obesity in the U.S. Affiliated Pacific region. CHL was funded by a five-year grant (2011-2016) that aimed to develop and test a community-driven multilevel, multi-jurisdiction intervention. The CHL intervention consisted of 19 activities categorized into four cross-cutting functions (CCF): CCF1 - review policies and assess the built environment; CCF2 - advocate and partner for environmental changes; CCF3 - promote CHL messages related to healthy behaviors; and CCF4 - build capacity. Because of the diverse settings and the community-driven intervention, the activities informed communities "what to do, but not how." For example, one required activity was to "work with existing organizations and coalitions and/or form new coalitions to advocate for better access to parks that are safe and inviting." The community determined exactly how parks could be improved and which resources to leverage. The CHL intervention progress was documented through monthly CHL-wide meetings and submitted monthly process reports detailing activity development, progress, and next steps (Braun et al, 2014). The CHL intervention effect was tested through a cluster randomized controlled trial (CRCT) in five jurisdictions where nine communities received the intervention, and nine matched communities served as delayed-intervention controls (Wilkens et al, 2013).

Few studies have documented and evaluated the implementation process, strategies and barriers associated with multilevel community interventions. An evaluation of a multisite ecologically based childhood obesity program conducted in Southern Australia (Richards et al, 2014), looked at barriers to implementing evidence-based strategies in 21communities that implemented the program. To understand factors that influenced the intervention's lack of fidelity and adaption, the article sorted strategies into whether they were adapted to local context or barriers to implementation and found that adaptations were made in order to implement the

strategies. The top barriers to implementation were political issues, resistance to changing social norms, lack of ownership of program and lack of a champion. The way staff adapted to these barriers was by taking ownership, investing more time, being persistent and allocating more resources into projects.

Building on Richards' study, data collected from the CHL intervention communities were analyzed to examine what strategies worked and what adaptations were made to implement the CHL intervention. The identification of CE implementation themes from the CHL intervention helped address the gap in multilevel and CE literature. This study's research question asked: Which CHL intervention strategies and technical adaptations can be applied towards implementing CE building block activities? It was hypothesized that the results of this study will show that adaptation strategies and techniques used by the CHL intervention can be translated to the CE MAM.

Methods

The qualitative case study design applied a theory-driven evaluation approach, cross-case analysis techniques, and was guided by program theory. Program theory is defined as a "set of explicit or implicit assumptions by stakeholders about what action is required to solve a social, educational or health problem and why the problem will respond to this action" (Chen, 1998, p.40). This approach provided insight on how the CHL intervention was operationalized and applied "transformative" processes to the CE MAM.

The theory-driven evaluation served to assess how and why the intervention was implemented and took into account the CHL intervention teams' views and concerns. The CE based theory looked at descriptive and prescriptive assumptions that underlaid the CHL program (Chen 2005). The descriptive assumptions were the causal processes that were expected to happen, in order to meet CHL program goals (i.e. building social cohesion around child health would lead to improved child health) and prescriptive assumptions were the actions needed for community change to occur (i.e. developing skills empowers community members) (Chen, 1990, 2005). Descriptive and prescriptive assumptions based on collective efficacy literature were used to relate the CHL intervention adaptation strategies to the CE building blocks.

To understand barriers that influenced the intervention's lack of fidelity to the underlying assumptions, the South Australian Obesity Prevention and Lifestyle (OPAL) initiative used cross-case analysis techniques (Richards et al, 2014). The initiative sorted strategies into whether

they were adapted to local context or barriers to implementation. These were the higher-order deductive categories into which basic and organizing themes were identified using cross-case analysis (Richards et al, 2014).

Similar cross-case analysis techniques were used for this study. Meaningful phrases from the CHL raw data were identified as being either strategies or barriers to implementing CHL intervention activities. Strategies and barriers were the higher-order categories. The phrases from the raw data identified as strategies were coded to basic themes derived from the CE literature, and then placed into CE building blocks organizing themes. The raw data, coded as barriers, were inductively coded into basic themes. Similarities in basic themes generated the barrier organizing themes.

The cross-case analysis allowed for the delineation of combinations of factors from the CHL intervention communities to further articulate the CE MAM. The process was used to understand how relationships existed among the intervention implementation strategies and techniques and the results were applied to the CE MAM (Ragin, 1997). The analysis of the implementation in the nine CHL communities provided an opportunity to learn from different intervention implementations and gathered critical evidence to understand how to operationalize the CE MAM.

Procedure

The primary data source was CHL intervention monthly process reports as they were directly related to intervention implementation. Monthly process reports from each of the nine intervention communities were submitted to the CHL coordinating center during the intervention phase of the program (January 2013 through December 2014). Monthly process reports required the jurisdictions to answer: What was done; Where was it conducted; How many participants were there; What progress was made in implementing the activity; and What were the next steps for implementing, expanding, or continuing the activity. The monthly process reports were purposefully broad to capture community tailoring of activities. For example, the intervention activity “better access to clean water” could include installing water bottle filling stations, installing water filters, installing water dispensers, etc., in various settings such as schools, churches, community centers, and parks. For completing the monthly process reports, an example would be: Installing water bottle filling stations (What was done); In community center (Where it was conducted); one community center (How many participants there were); Water

bottle station hooked-up and operational (What progress was made); and install water bottle filling station at elementary school (Next steps).

The secondary data source was the CHL intervention team meeting minutes. Meetings were conducted by teleconference on a weekly basis from August 2012 through May 2013. From May 2013 to March 2015 monthly intervention teleconferences were held. The meetings were used to discuss intervention strategies, to share and learn from other communities, and to focus on common challenges faced in the CHL intervention.

The qualitative analysis used a four step process with inductive and deductive coding. 1) Text from the monthly intervention reports and CHL-wide intervention meeting notes were identified, sorted into the cross-cutting function they addressed, and assigned a "high" or "low" group code (high and low dose group described subsequently). 2) The text was coded and categorized into the higher-order themes of strategy or barrier to implementation. Barriers to implementation included both issues that slowed activity implementation and those that prevented intervention implementation. 3) For implementation strategies, both deductive basic themes and organizing themes based on the five CE building blocks were identified. The organizing themes were the five CE building blocks, and the basic themes were words and phrases linked to a CE building block as derived from the CE literature (Alsop & Heinsohn, 2005; Collins, Neal, & Neal, 2014; Larson, 2004; Woolcock, 2001) (Table 6.1). Barriers to implementation were inductively coded and organized. 4) Subsequently, the intervention meeting minutes were analyzed to further explore strategies and barriers. When no new themes or codes were identified, saturation was considered to be achieved (Mason, 2010). NVivo 11 (2016) software was used for coding and analysis.

Butel (2017) used a five point scale to score the amount an implemented activity addressed each CE building block. The score for each CE building block was summed to get the total CE dose for each community. Four CHL intervention communities had a total CE dose of greater than 200 and were designated as "high dose" communities. The other five communities had a dose of less than 200 and were designated as "low dose" communities. Each of the nine CHL intervention communities were designated as a case and assigned a group attribute of either "high" or "low" based on total CE intervention dose. High and low dose groups were examined across the four CCFs codes, basic themes, and organizing themes for implementation strategies; and implementation barriers were compared and contrasted for similarities and differences

between the high and low dose groups. Overarching strategies and barriers to implementation were identified, as well as strategies and barriers, specific to each of the two groups.

Table 6. 1. ***Implementation Strategies, Coding Themes, and Definitions***

Organizing Theme: Civic Engagement	
Basic Theme	Definition
Community Action	actions that begin community change
Advocacy	promote policies to elected officials
Community change	sustain change to environment or social norms
Policy Enactment	enact policy in setting or community
Organizing Theme: Empowerment	
Basic Theme	Definition
Create awareness	demonstration of activity
Cultural skill development	learn skills related to culture
Giving voice to community	presentations by community member/group
Leadership	community member/group leading activity
Skills development	learn skills related to CHL behavior(s)
Training others	community member teach learned skills
Organizing Theme: Social Bonding	
Basic Theme	Definition
Building bonds	establish trust through interactions
Buy-in	agreement on strategy and direction
Seeking buy-in	ask for input about strategies and activities
Commitment	regular support for activity or strategy
Connections	introduction to others through partnerships
Strengthen	regular communication and interactions
Organizing Theme: Social Bridging	
Basic Theme	Definition
Asset	community partner provide tangible resource
Bring together	connect different groups together through activity
Collaboration	two or more partners make contributions and work together
Community input	community members input sought on activity
Community messaging	message going out to all in community
Culturally appropriate	follow cultural protocol or norms
Identify	seek partners or community members
Information gathering	obtain information from partners or community
Linking	connect partners to assist in activities
Providing information	give gathered information back to the community
Reaching out	talk or meet with groups to obtain interest
Solicit donations	request resources from organizations/business
Working with a planned event	conduct activity in already planned event

Organizing Theme: Social Leveraging

Basic Theme	Definition
Access	allow access for activity to occur
Outside Expertise	experts providing training
Building on current efforts	work with other large organization's activity
Manpower	personnel assistance from large organization
Material development	develop CHL materials
Technical skills	leverage specialized skills
Building on current program	add-to or modify an established program
Developed process	establish procedure to work with organization
Leader buy-in	elected official or key leader support of activity
Other grant support	enlist resources from other grant resources
Purchased supplies	bought supplies to implement activities
Seeking Leadership buy in	request support of elected officials or key leaders
Support	large organization provides resources for activity
Adopt activity	large organization adopts CHL activity
Advertise through agency	promote CHL message through agency connections/venues
Permission to use	organization granted permission to conduct activity
Use of program supplies	CHL activity use of supplies of large organization

To ensure accounting of the identified strategies and barriers was robust and complete, one-on-one intervention meeting notes were reviewed. The one-on-one intervention meetings were conducted via teleconference from January 2013 to December 2015 between the CHL intervention leads and each jurisdiction. Topics and challenges specific to each community in the jurisdiction were discussed. The use of three different data sources served to triangulate the findings. Triangulation facilitated the validation of the coding through cross verification from the three sources (Denscombe, 2014). The identified implementation strategy themes and barriers themes were sent to CHL staff members who implemented the intervention activities to ensure accuracy and completeness.

Data coding rigor was determined using Lincoln and Guba's (1985) criteria of credibility, transferability, dependability, and confirmability. The intervention process reports followed a standardized template and were systematically collected monthly during the intervention period lending credibility to the primary data source. Built in checks using other CHL data sources for verification assisted in ensuring the data was credible.

The multilevel, multisite design of the intervention, with its latitude in how the intervention was implemented, provided a variety of information to consider when applying

findings of this study to other similar studies. Dependability (reliability) of the text coding and relating the codes to the deductive CE themes was based in CE theory and the researcher's knowledge of the CHL intervention. Confirmability (objectivity) was maintained through a systematic process of coding and provided a framework to conduct thorough research. The reflexivity of the primary researcher was considered, since the researcher served as the CHL Intervention Coordinator throughout the intervention. The role of Intervention Coordinator and developer of intervention trainings and activities provided privileged insight and can be regarded as a resource (Denscombe, 2014). The use of a systematic process, questions, maintaining an audit trail, triangulation of the data, and staff member checking, provided guidance to ensure comprehensiveness and accuracy. The CHL program was approved by the University of Hawai'i at Mānoa, University of Alaska at Fairbanks, and University of Guam's Institutional Review Boards. The other participating College (Northern Marianas College and American Samoa Community College) ceded IRB approval to the University of Hawai'i at Mānoa.

Results

From the two data sources, 1,274 meaningful phrases were coded to 47 basic strategy themes and 224 meaningful phrases were coded to 17 basic barrier themes. Of phrases coded for strategies, 1,218 came from the monthly process reports and 56 from the intervention team meeting minutes; with no new codes coming from the one-on-one jurisdiction meeting minutes. Of the barrier-coded phrases, 158 came from the monthly process reports, and 66 came from the intervention team meeting minutes. The intervention team meetings from 2013 yielded three additional barrier themes and the 2014 intervention team meeting minutes added no new codes. The one-on-one intervention meeting notes verified the strategy and barrier coding themes. Member checks sent to CHL jurisdiction team members found the themes to accurately represent the strategies and barriers of their communities' activities.

The organizing strategy themes of social bridging and empowerment were coded most often, 445 and 425 times respectively, across the CHL intervention communities. Social leveraging was coded 225 times, civic engagement themes coded 94 times and social bonding themes coded 85 times. Examining the overall counts by each cross-cutting function, civic engagement and social leveraging counts were highest for CCF2 (environmental change) and CCF4 (capacity building); empowerment themes coded highest for CCF3 (messaging) and CCF4 (capacity building); social bonding and social bridging theme counts were highest for CCF2

(environmental change) and CCF3 (messaging) (Figure 6.2). None of the CE building blocks were the highest for CCF1 (Review policies and assess environment).

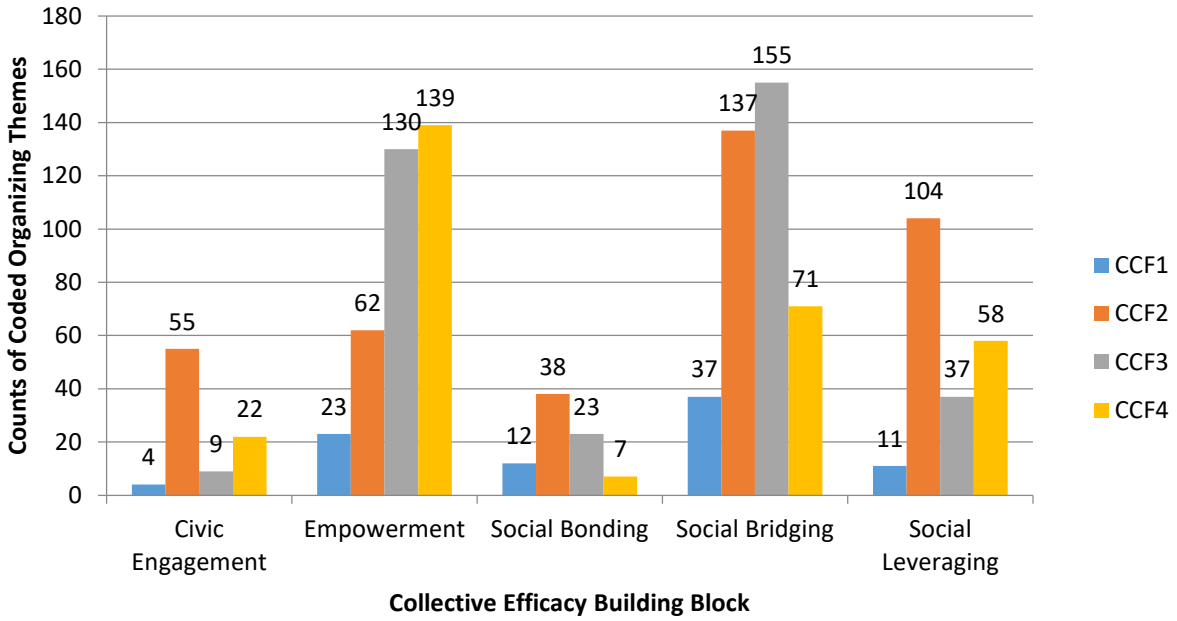


Figure 6. 2. Organizing Theme Counts by Cross-cutting Function

To understand the relationship between CE building block strategies and groups of related activities the percentage of CE building block strategies were linked to each CCF (Figure 6.3). Over 65% of activities relating to CCF1 (review policies and assess the built environment) were social bridging and empowerment strategy themes. For CCF2 (advocate and partner for environmental changes), 60% of the strategies were coded to social bridging and social leveraging. Of activities that promoted CHL messages related to healthy behavior (CCF3) strategies, 81% were coded to empowerment and social bridging. Empowerment and social bridging themes accounted for 71% of building-capacity (CCF4) strategies.

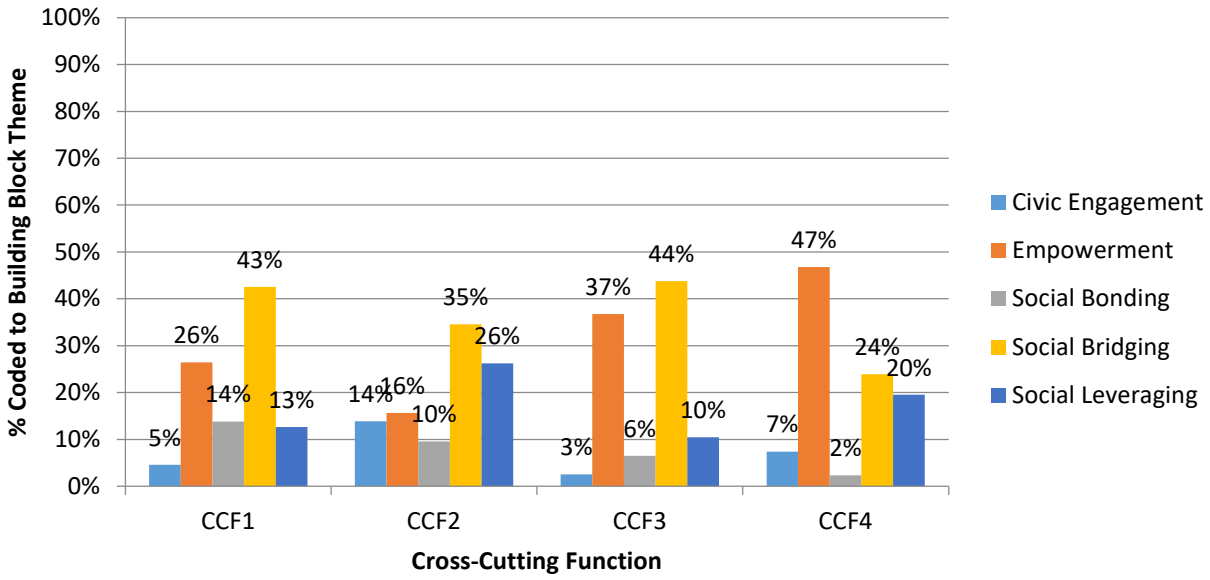


Figure 6. 3. ***Percentage of CE Building Block Strategies by CCF***

To understand the types of activities the strategies addressed further analysis examined the number of strategy codes for the high and low dose CHL intervention groups by CCF (Figure 6.4). There was a slight difference in the amount of text coded by CCF between the groups. The low dose group had 1.5 times the amount of text coded to CCF1 compared to the high dose group. The high dose group had 1.6 times the amount coded to CCF2 compared to the low dose group and 1.3 times the amount coded to CCF3. CCF4 coding was essentially the same between the high and low dose groups.

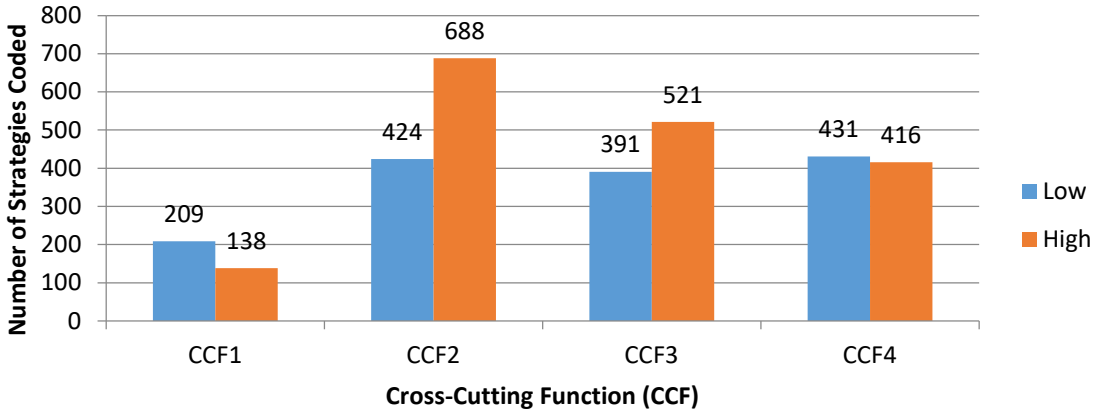


Figure 6. 4. ***Number of Cross-Cutting Function Strategies Coded by Dose Group***

The high and low dose groups were examined by CE building block theme (Figure 6.5). The high dose CHL intervention group had three times the number of text coded to civic

engagement themes and two times the number coded to social bonding themes. The high dose group coded 1.3 times more for empowerment than the low dose group, and the low dose group coded more for social bridging and social leveraging than the high dose group, 1.1 times more and 1.2 times more, respectively.

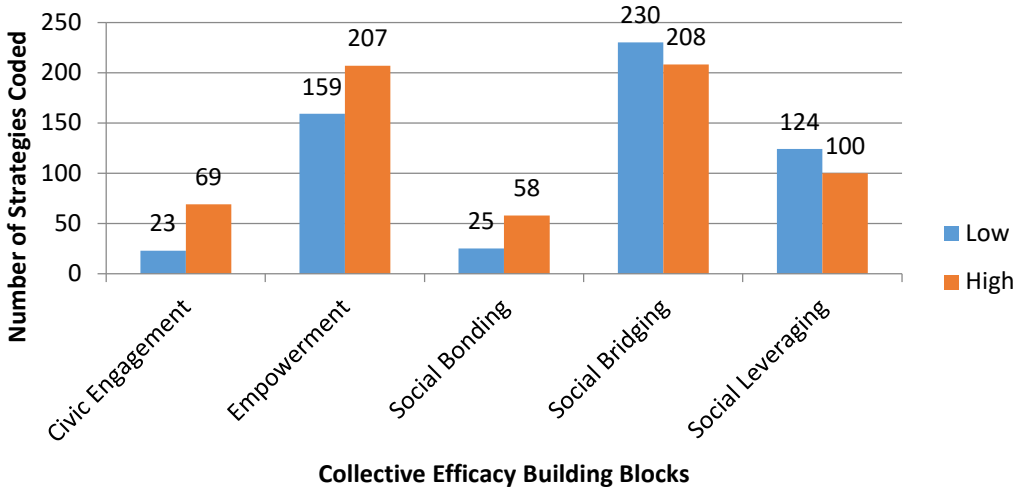


Figure 6. 5. ***CE Building Block Strategy Themes by Dose Group***

The strategy themes were evaluated to understand specific strategies that aided the implementation of CHL activities. Of the top 20 overall basic strategy themes the top three were organized into empowerment themes and the rest of the top ten basic themes were either social bridging or social leveraging organizing themes. Civic engagement and social bonding organizing themes had one of each, numbers 11 and 19, respectively. Examples of coded text for the top 20 basic themes are shown in Table 6.2.

Table 6. 2. ***Example Coded Text for Top 20 Basic Implementation Strategy Themes***

Organizing\Basic theme	Example Coded Text
1.Empowerment\Skills development	*Trainings conducted with PSS-Head Start Teachers, …*
2. Empowerment\Create awareness	*Taste testing to introduce as well as promote new, fun and still healthier ways of drinking "water" to young children*
3. Empowerment\Leadership	*RM's [role models] promote and encourage others in their community to join their Monday walks*
4. Social Bridging\Community messaging	*Distributed a total of 400 scavenger hunt brochures at trail heads, with childcare providers, and to schools*
5. Social Leveraging\Building on	*We continue to update the Fairbanks Families*

Organizing\Basic theme	Example Coded Text
current program	*Recreation Resources website by compiling information about kids and outdoor trail activities*
6. Social Bridging\Information gathering	*Conduct community assessments*
7. Social Bridging\Reaching out	*Reached out to Master Gardener coordinator to gauge interest in partnering with CHL*
8. Social Leveraging\Material development	*Revised CHL Tip sheets based on community members' recommendations*
9. Social Bridging\Community input	*Role models were solicited for ideas of future projects*
10. Social Leveraging\Enlist Outside Experts	*Training conducted by Dr. Nigg on August 30 and August 31*
11. Civic Engagement\Action	*CHL staff and RMs [role models] began painting on 8/9 [playgrounds]*
12. Social Leveraging\Purchased supplies	*Have bought materials that include lumber (for gardening boxes), fertilizers, and others*
13. Social Leveraging\Developed process	*sent out mini-grant contracts for signature*
14. Social Bridging\Working with a planned event	*CHL booth at Active Hawaii Family Fun Fest; attended Ka Pua Event; Work 'n Learn Day at Ka'ala Farm*
15. Empowerment\Cultural development	*Papa ku'i'ai Workshop- Wood Gathering (for the kalo pounding boards)*
16. Social Bridging\Identify	*We will identify which groups in our sites willing to accept our assistance to work with them to develop a wellness policy for their school*
17. Social Bridging\Collaboration	*Had conference call with XXXX at UOG to discuss the possible collaboration on Gardening Curriculum Training*
18. Social Bridging\Linking	*Communicated to Extension Department and CNR Horticulturalist for other gardening tips and such to be planted at her home,…*
19. Social Bonding\Seeking buy-in	*Role models to meet and discuss Healthy stores intervention*
20. Social Bridging\Culturally appropriate	*Translation/distribution of letters to Aua community members, church ministers, etc*

There were variations in basic theme strategies between the high and low dose groups. Examining the ten most frequently coded basic themes, Figure 6.6 illustrates similar and different basic themes between the high and low dose groups for overall activities.

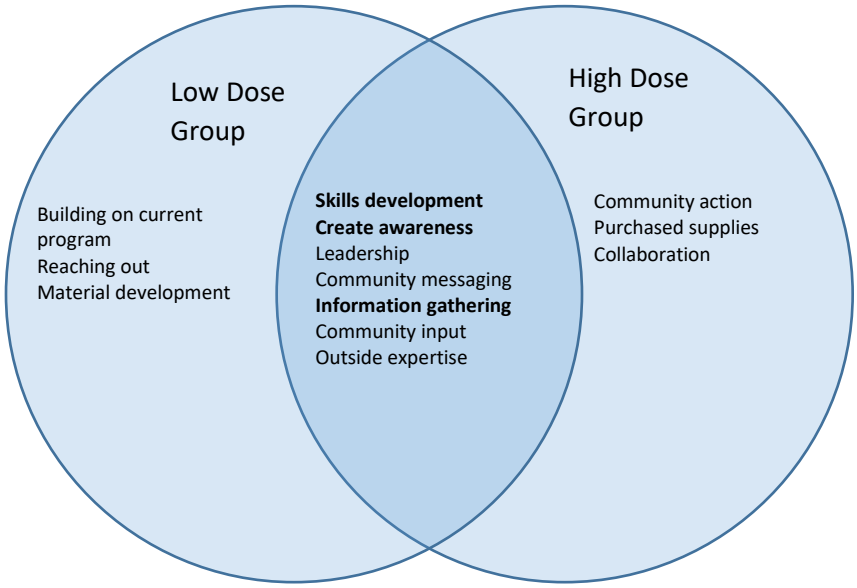


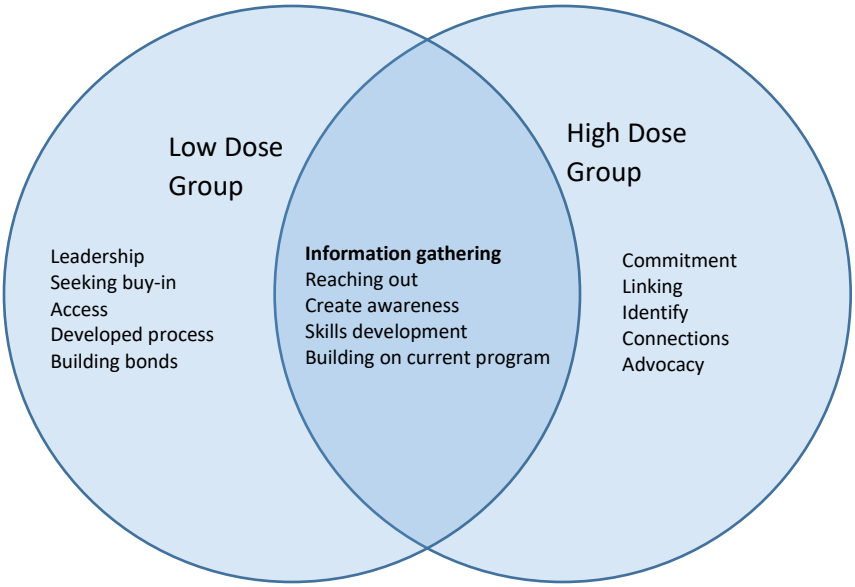
Figure 6. 6. ***Top Ten Basic Strategy Themes by Dose Group for Overall Activities***

In the figure, the overlapping circles illustrate similar basic themes, the basic themes are listed in descending rank order, and the bolded basic themes were the same rank for both groups. Seven of the most commonly coded basic themes were the same between the groups, with three being organized into empowerment and social bridging, and one being organized into social leveraging. There was variation between the other three basic themes. The basic theme differences between the two dose groups were organizing themes of social bridging and social leveraging, however the high dose group had one basic theme that was organized into civic engagement.

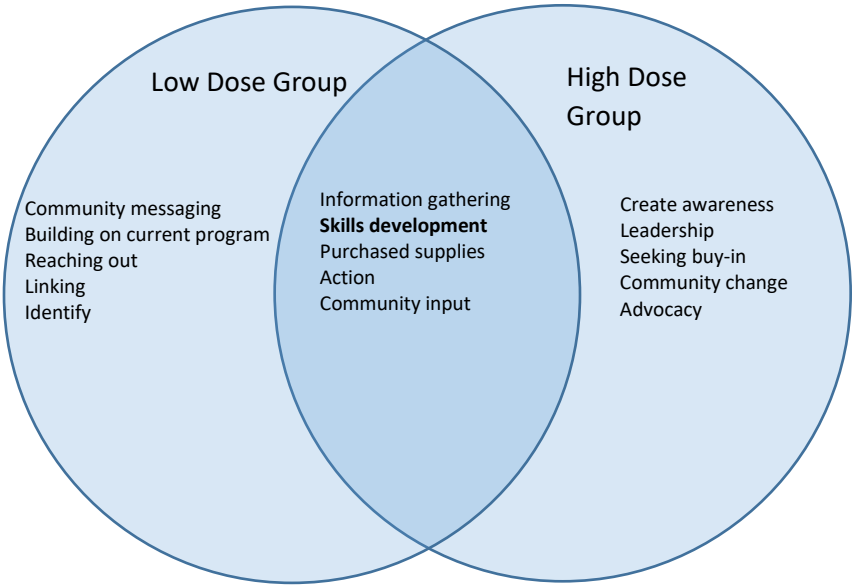
To explore strategies used to implement activities, the ten most commonly coded basic themes for each CCF were examined (Figure 6.7). Six basic themes were the same for both groups for CCF1, five basic themes were the same for both groups for CCF2, CCF3, and CCF4

with seven similar themes for both groups. Skills development was the only basic theme seen in both groups for all CCFs.

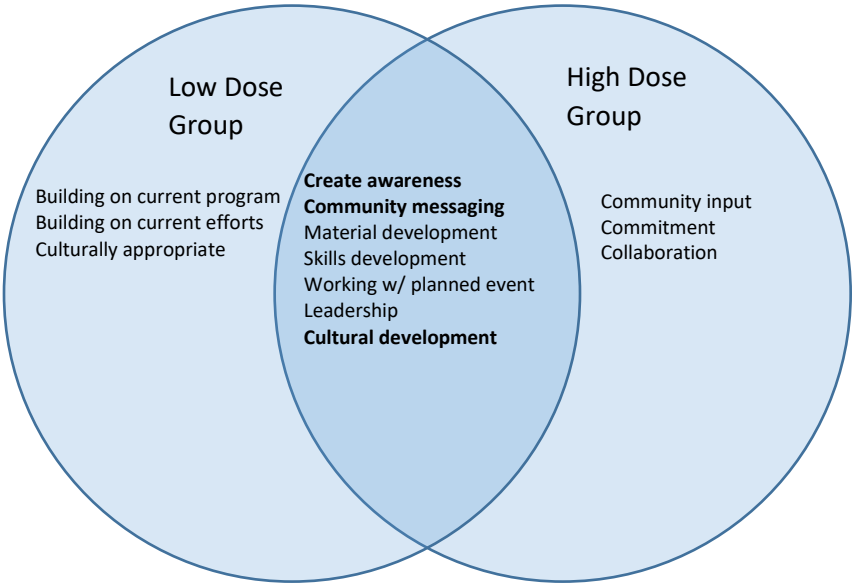
Basic Theme Strategies for CCF1 (Review Policies and Assess the Built Environment)



Basic Theme Strategies for CCF2 (Advocate and Partner for Environmental Changes)



Basic Theme Strategies for CCF3 (Promoted CHL Messages Related to Healthy Behavior)



Basic Theme Strategies for CCF4 (Capacity building)

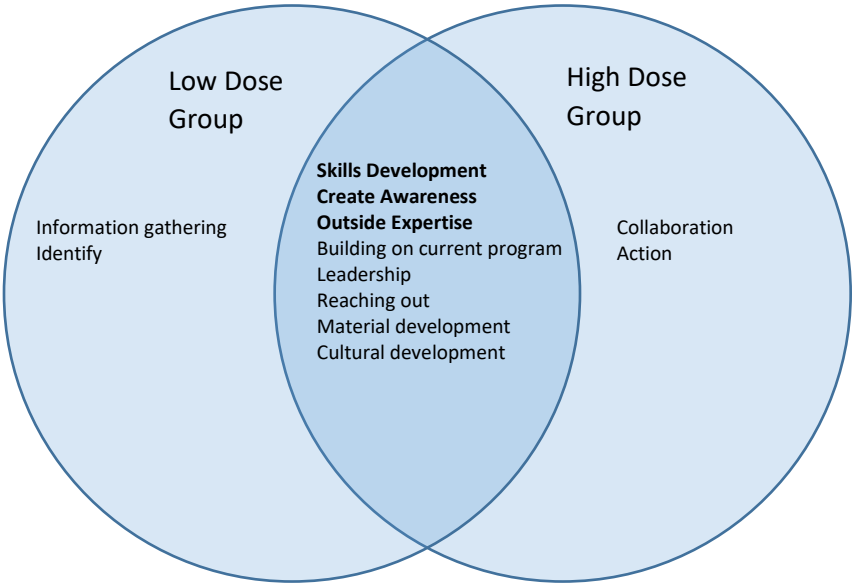


Figure 6. 7. ***Top Ten Basic Strategy Themes by Dose Group for each Cross-Cutting Function***

The 17 inductively coded barriers to implementing the CHL intervention were organized into seven themes (Table 6.3). The barriers were coded by high and low total CE dose communities. Due to the overlapping nature of the codes they were not coded to specific CCFs. In addition, there was an additional identified theme, not applicable. Not applicable was coded to text when the activity was not implemented due to the activity already being addressed. For example, one CHL activity was to partner with local groups to provide drinking water in preschools. An example coded text was "*Drinking water already being provided in preschools and elementary schools"*. Not applicable was coded eight times in the text.

Table 6. 3. ***Barriers to CHL Activity Implementation with Example Coded Text***

Organizing\Basic theme	Example Coded Text
Complexity\Multilevel approvals	*Rotary Club is in the process of obtaining an MOU from the Governor's office*
Complexity\Policy complexity	*New policies would require authorization from DOE Director and other education boards members to agree upon in order to implement in schools*
Complexity\Program complexity	*These communities are waiting for direction on what to do… we need to give them purpose to rally behind*
Delays\Organizational delays	*Waiting for initial meeting with day care director*
Delays\Procurement delays	*PO [purchase order] currently processing*
Delays\Program Delays	*You should start intervention when you complete your baseline measurements*
Delays\Scheduling conflict	*Postponed till further notice due to scheduling*
Environmental\Unsafe environment	*Public schools, however, have closed after-hour access owing to vandalism*
Environmental\Weather	*TBD. Parks are currently snowed under*
Modifications\Material development	*Waiting to see what comes from focus groups for 5210 preschool campaign*
Modifications\Required Local Modifications	*It will be up to each jurisdiction to build their own fact sheet with specific foods, activities to their jurisdiction*
Priorities\Conflicting priorities	*focus away from data gathering and more on interventions*

Organizing\Basic theme	Example Coded Text
Priorities\Lack of Champion	*Find champion to talk to store owners*
Priorities\Low priority	*Most of the sites we reviewed did not have wellness policies, we do not currently have plans to address this*
Resources\Lack of resources	*We learned that they closed access because of electricity costs*
Resources\Workload	*It is expected to take about 100 manpower hours per community—that does not include the walkability form*
Technical problems\Technical problems	*Intermittent access [to CHL computer server]*

Of the 224 meaningful text coded to barriers, 52 were coded to not implemented activities and the remaining 172 coded text were barriers that were overcome by the CHL intervention communities. The main basic theme barrier to not implemented activities barriers was "low priority" followed by "lack of resources" (Table 6.4). Forty were coded to the low dose group versus 11 being coded to the high dose group.

Table 6. 4. ***Not Implemented Activity Barriers by Dose Group***

Organizing\Basic Theme	Number of phrases coded to Low Dose Group	Number of phrases coded to High Dose Group
Priorities\Low priority	11	2
Resources\Lack of resources	9	1
Delays\Organizational delays	6	3
Priorities\Lack of Champion	4	2
Delays\Scheduling conflict	4	2
Complexity\Policy complexity	2	1
Complexity\Program complexity	2	0
Resources\Workload	2	0
Complexity\Multilevel approvals	1	0

Overall, the main organizing barrier to implementing CHL activities was "delays" followed by "modifications" (Figure 6.8). The amount of text coded to these two organizing

barrier themes was similar for both dose groups. Complexity, priorities, resources and environment organizing barrier themes were 1.8, 1.9, 1.9, and 2.5 times higher respectively for the low dose group as compared to the high dose group.

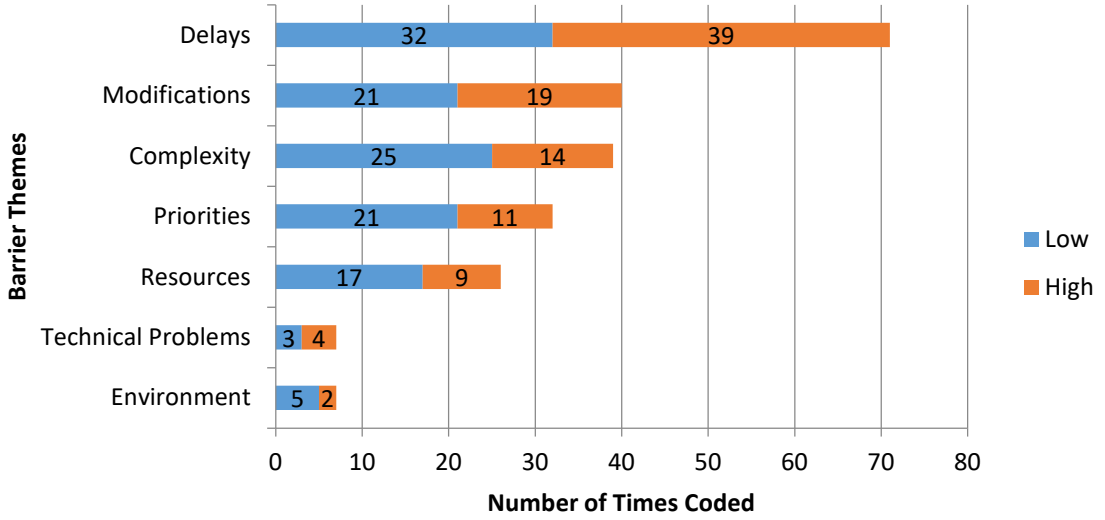


Figure 6. 8. ***Organizing Barrier Themes by Dose Group***

Four of the top five basic barrier themes were the same for both dose groups (Figure 6.9). Procurement delays was the top barrier for the high dose group; however, it ranked 9th for the low dose group. The basic barrier theme – lack of community champion - was ranked 5th in the low dose group and was ranked 15th in the high dose group.

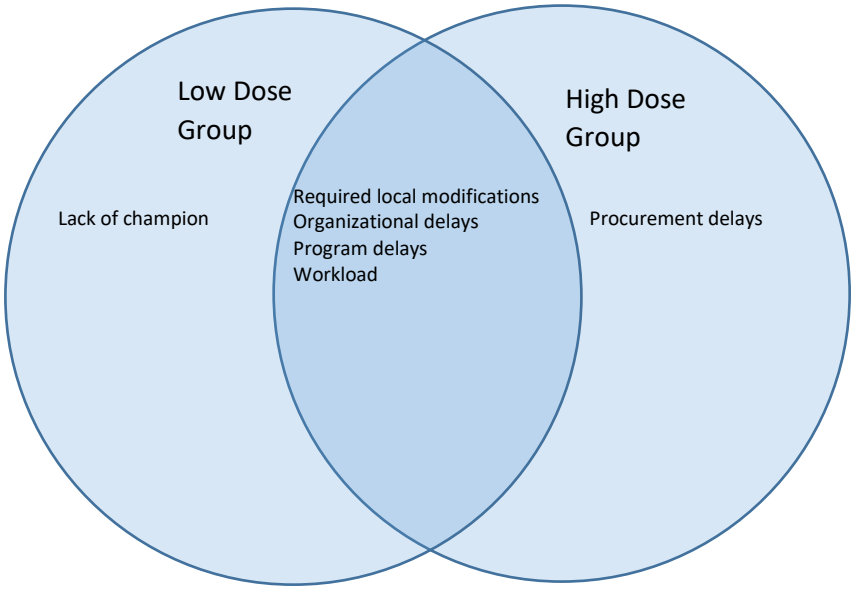


Figure 6. 9. ***Top Five Basic Barrier Themes by Group***

To understand the progression of implementation and the effect of barriers on CE and community interventions a phased chart based on the strategies and barriers of the CHL intervention was created (Figure 6.10). The progression of implementation phases integrated the concepts of CE as outlined by Ohmer (2016), and the strategies used to implement the CHL intervention. The effect of the barriers on the implementation phases incorporated the findings of Richards (2014) and the findings from the CHL intervention barriers. Figure 6.10 displays activity development strategies and the barrier arrows indicate potential points of implementation delay. The earlier in the progression (e.g., Phases 1 and 2) the barriers occurred, the greater the risk of implementation failure.

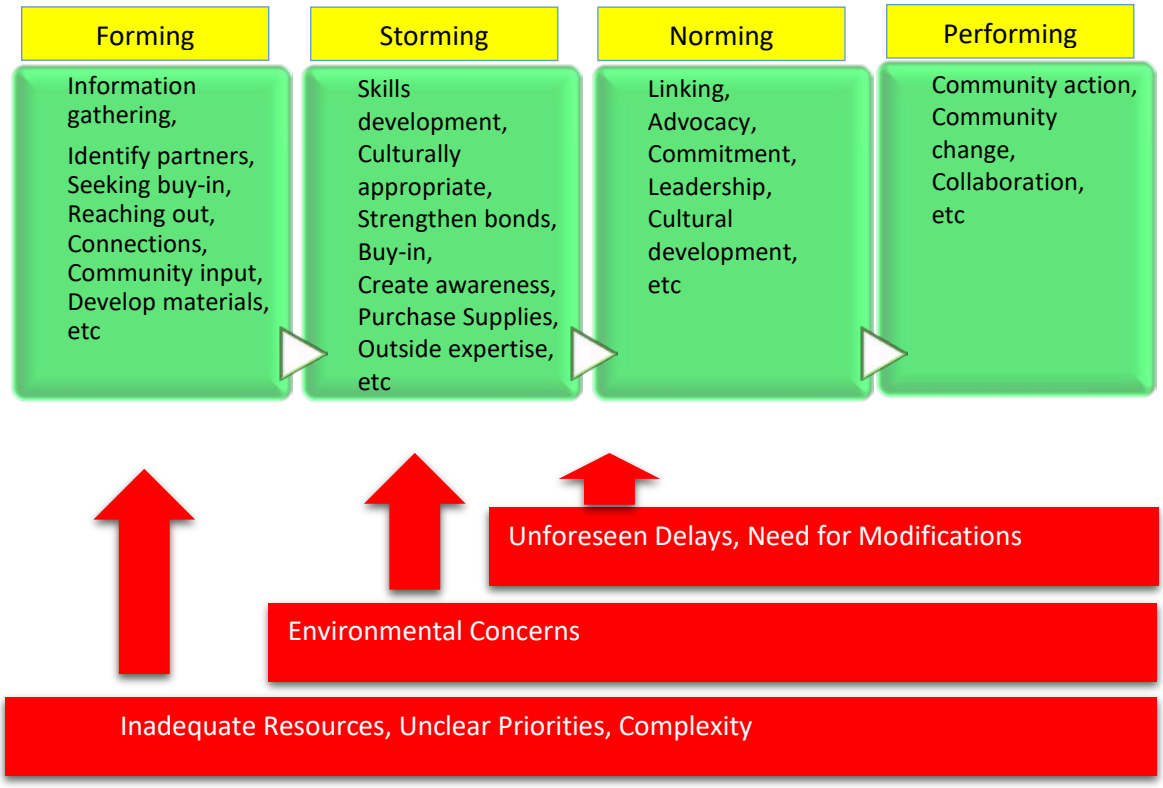


Figure 6. 10. ***Barrier Effects on Implementation Progression***

Discussion

The interplay of strategies involving all five CE building blocks in the cross-case analysis of CHL intervention could indicate that multiple strategies are required to implement multilevel community-level interventions. The strategies and barriers identified in the implementation of

the CHL intervention indicate methods that may assist communities in the process of implementing complex interventions using the CE MAM. The six following findings point to CE MAM implementation methods: 1) Establish diverse ties in the community using social bridging strategies; 2) Build capacity in all activities through empowerment strategies; 3) Use resources and expertise in social leveraging strategies to help establish community-led initiatives; 4) Include civic engagement and social bonding strategies in community interventions; 5) Build in time for delays and required modifications; and 6) Address complexity, resources, and priorities, since they affect implementation.

Establish diverse ties in the community using social bridging strategies

Social bridging strategies played a major role in the implementation of the assorted intervention activities in the CHL intervention, especially the basic themes of information gathering, reaching out, and community messaging. These basic themes indicate the need to establish diverse ties in the community when implementing community-level interventions. This supports the findings of the Strong Communities for Children initiative which increased collective efficacy in communities (McDonell, Ben-Arieh, & Melton, 2015). The initiative found that to keep kids safe it was important to understand the nature of the problem (gather information) and to "spread the word" (community messaging). In addition, the initiative reached out to diverse groups in the communities (Kimbrough-Melton & Melton, 2015). During the CHL intervention, CHL staff reached out to various groups in the community that were involved with the health and wellbeing of young children and gathered information from community partners about their community to tailor community messages that resonated with community members.

Build capacity in all activities through empowerment strategies

Empowerment strategies appeared to work hand-in-hand with social bridging strategies. Empowerment strategies, in particular the basic themes of skills development and create awareness, were important to build capacity in all CCFs. Skills development strategies used by Carlson, Brennan, and Earls (2012) to empower youth to address HIV were found to positively affect CE. Skill development was the most commonly coded strategy in the CHL intervention and examples of skills development ranged from assisting partners with grant writing skills, role model training with community members, physical activity workshops with teachers, to hands-on gardening and cooking workshops with families.

Use resources and expertise in social leveraging strategies to help establish community-led initiatives

Although the CHL intervention employed social bridging and empowerment strategies most frequently, social leveraging strategies were utilized to garner resources and engage expertise not found in the community. For example, CHL teams provided supplies for playground improvements and brought in outside experts to provide training and technical support for the communities. Drawing from the social capital literature, Dominguez and Alford (2012) found the injection of resources into underserved communities serves to support community-driven initiatives and allows the initiatives to take root and flourish. In addition, they found that engagement of outside experts increased access to information and opportunities that built capacity in communities (Dominguez & Alford, 2012).

Include civic engagement and social bonding strategies in community interventions

Strategies coded to empowerment, social leveraging, and social bridging were similar in both groups, however civic engagement and social bonding strategies were seen more often in the high dose group. The inclusion of civic engagement strategies and social building strategies should be considered when implementing CE community-level interventions. This is supported by findings found by Collins (2014) that provided evidence that the relationship between civic engagement and collective efficacy is partially mediated through social bonding. This is highlighted by basic strategy themes difference between the high and low dose groups. The more frequent coding of the basic themes of action, advocacy and community change (civic engagement strategies); and more seeking buy-in, commitment, and connections (social bonding strategies) along with collaboration by the high dose group, indicates a link between civic engagement and social bonding. To illustrate this through a CHL example, meetings and support of CHL role models were conducted on a regular basis and the role models led community actions and advocacy. However, this does not diminish the contributions made by other CE building block strategies. Using the role model example, the role models were identified by community partners (social bridging), trained (empowerment) by outside experts (social leveraging), and supported by purchase of supplies (social leveraging) for many of the activities they implemented. The development of role models was a process that engaged strategies from all CE building blocks.

Build in time for delays and required modifications

Strategies to implement CHL activities needed time for modification, and to account for delays from community partners and the CHL program. According to the presentation at the 2014 CHL annual meeting, the CHL monthly intervention process reports showed that it wasn't until 12 months (December 2013) into the two-year intervention that "implemented activities" were reported more frequently than "planning to implement" activities. For example, the CHL-wide social marketing campaign was launched in January 2014 due to the need to tailor the materials to each community and develop a social marketing plan. An example of an organizational delay was the delay in planting of school gardens due to school breaks. In developing a CE intervention, Ohmer (2016) suggests a five month period to organize and build relationships. The Strong Communities for Children initiative website states "full implementation of the initiative is expected to require 10 years" (The California Evidence-Based Clearinghouse for Child Welfare, http://www.cebc4cw.org/program/strong-communities-for-children/detailed). The CHL experience indicates that it takes at least one year to transition from planning activities to implementing activities.

Address complexity, resources, and priorities as they affect implementation

Even though time is essential to implementing CE intervention there is a need to address complexity, and resource and priority barriers, since they both affect implementation. The frequency of coding these barriers was higher in the low dose group, and eight out of ten of the barriers of non-implemented activities were basic themes of these organizing themes. Richards et al, (2014) found similar barriers in their analysis of a community-based childhood obesity prevention intervention. For example, Richards (2014) and team, identified human resources, financial resources, political issues, and competing priorities to be implementation barriers. Figure 6.10 illustrates the need to clarify priorities to communities, for those working with communities to understand and address complexities, and ensure there are adequate resources to obtain the desired results.

Limitations

There were recognized limitations to this study. The retrospective nature of the study relied on the accuracy of reports and limited the use of interviews due to recall bias of the interviewees. In addition, the coding process may be inaccurate. There were four months of missing reports from one community and delays in reporting from two other communities.

However, through triangulation the effect of the missing data was minimized. These limitations have the potential to inaccurately reflect the activities barriers and adaptations. However, the volume of codes (nearly 1,500 meaningful phrases were coded as strategies or barriers) from various sources allowed for triangulation of the data to verify the themes. In addition, CHL jurisdiction intervention team member checking, the researcher's intimate knowledge of the CHL intervention, and access to CHL intervention developers and implementers assisted in assuring accuracy.

The specific nature of the CHL intervention (childhood obesity in the U.S. Affiliated Pacific) and that the intervention did not specifically address CE may have limited the strategies and barriers identified, and their transferability to CE. However, the multilevel multi-jurisdiction nature of the CHL intervention involved implementation of similar activities as identified CE interventions. Having nine communities in five jurisdictions conduct the activities in partnership with community partners provided a unique opportunity to learn from different intervention implementations and gathered critical evidence to be applied to and inform the CE MAM.

Conclusion

The ability to analyze data collected monthly from nine communities concurrently implementing the same intervention framework with community variations for 24 months provided an opportunity to explore implementation strategies and barriers, and apply them to the CE MAM. The cross-case analysis of CHL intervention communities identified CE building block themed implementation strategies that provided insight into ways to operationalize the CE MAM. The nuances of interactions of CE building block strategies as they were applied to the four CCFs (review policies and assess the built environment; advocate and partner for environmental changes; promote CHL messages related to healthy behaviors; and build capacity) helped to elucidate what is needed to implement CE activities.

Understanding the barriers inherent in community work and finding ways to minimize their impact on intervention implementation will not only allow for better outcomes, but may be applicable to other community organizing endeavors. By examining the strategies used and the barriers encountered by the CHL intervention communities an understanding of how to operationalize the CE MAM was elucidated. This may assist program developers, interventionist and community groups to develop a process to mimic high dose community strategies and limit barriers seen in the low dose communities.

CHAPTER 7. DISCUSSION AND CONCLUSIONS

Improving community health outcomes is a complex task and requires addressing multiple factors at multiple levels (Glanz & Bishop, 2010). Implementation of multilevel interventions in a way that includes community members, considers culture, and grasps the dynamics of daily living can be daunting and complicated. The concept of collective efficacy (CE, defined as community capacity to effect change) is relevant to implementation of community interventions. This dissertation introduced the CE mechanism of action (MAM), a model showing how intervention activities can strengthen the five building blocks of CE—social bonding, social bridging, social leveraging, empowerment, and civic engagement—to increase CE to improve health outcomes. Chapter 2 (a literature review on CE) and Chapter 3) (a calculation of CHL intervention dose) presented foundational, background information for this dissertation. Chapters 4 through 6 reported the methods and findings from three studies on ways to apply, measure, and evaluate the CE MAM through a cross-case analysis of nine CHL intervention communities. Each of the nine communities concurrently implemented the same intervention framework (with community variations), and data for this dissertation were gleaned from monthly progress reports collected from each community over the 24-month CHL intervention.

Summary of Main Findings

The recommendations from the 2015 National Heart, Lung, and Blood Institute (NHLBI) workgroup guided the research of this dissertation. The main dissertation research findings support the use of the CE MAM to operationalize the NHLBI workgroup's recommendations. The workgroup's four recommendations for implementing multilevel interventions were: *1) Include persons indigenous to the area or setting in all phases of the planning and implementation process. 2) Acknowledge the high level of heterogeneity in participant response to treatment by incorporating an adaptive intervention approach. Use empirical novel statistical tools to find the best tailoring variables for better characterizing patient's heterogeneity. 3) Consider secondary analysis questions regarding the relationship between dose across multiple settings (including synergistic effects) and study outcomes. 4) Use a clearly articulated conceptual model showing the relationships among major intervention components or a program planning model to guide the choice of the intervention components.* (National Heart, Lung, and

Blood Institute, 2015 https://www.nhlbi.nih.gov/research/reports/intervention-recs-for-high-risk-populations).

CE interventions have shown promise in addressing community health outcomes (Butel & Braun, 2016). Chapter 4 indicates that the CHL intervention implemented CE activities. The chapter examined CHL intervention data with a focus on how CE intervention activities effected reduction in screen time addressing the NHLBI's recommendation "*Consider secondary analysis questions regarding the relationship between dose across multiple settings (including synergistic effects) and study outcomes.*" (National Heart, Lung, and Blood Institute, 2015 https://www.nhlbi.nih.gov/research/reports/intervention-recs-for-high-risk-populations).

Quantitative analysis of the CE intervention dose of CHL intervention activities confirmed a correlation between CE intervention dose and decrease in screen time, showed interaction between the CE building blocks in implementation, and the effect of civic engagement activities on screen time. Differences in the CE dose between communities showed that communities with a higher total CE intervention dose realized a larger decrease in screen time compared to communities with a lower total CE intervention dose. The study supported findings in the literature that implementation of activities promoting civic engagement are needed to effect change (Butel & Braun, 2016). Including activities that communities can directly act on in interventions may increase impact on outcomes. These findings suggest the CEMAM framework may guide community-level interventions to address childhood obesity prevention.

CE inherently includes persons "indigenous to the area" as it seeks to build social cohesion and the willingness to act/intervene in neighborhoods and communities (Sampson, Radenbush, & Earls, 1997). By examining the CHL community networks through the CE MAM lens, chapter 5 analyzed the community relationships CHL built to implement CE related activities. This study identified the community implementers that assisted in implementing CHL activities in predominately indigenous communities (Wilken et al, 2013).

The social network analysis of community implementers assisting with implementation of CHL activities identified the emergence of a community implementer backbone consisting of local schools, community-based groups, and large organizations. The role of large organizations in communities appeared to be a supporting role, as indicated by the strong relationship of social leveraging to the other CE building blocks. This adds to Sandel's (2016) findings that supporting

capacity development, merging multiple funding streams, and investment of resources in underserved communities are needed to have successful community-level interventions.

The density of the community networks increased over time, validating the need for sufficient time for relationships to develop. Communities that implemented more total activities also developed denser networks, engaged more community-based groups, and realized greater decreases in screen time compared to communities with less developed networks. These findings align with other research showing that development of community-based groups has the potential to lead to better health outcomes (Gibbons & Weiss, 2012; Scanlon et al., 2012). These findings also support the use of CE MAM to identify relationships with and between multiple types of community implementers to engage persons indigenous to the area.

The CE MAM was found to be an "adaptive intervention approach" as it could be articulated to the strategies and barriers used by the social ecologically based CHL intervention. Chapter 6 identified the strategies applied towards CE MAM building blocks as utilized by the CHL intervention and recognized implementation barriers thus, indicating the ability of the CE MAM to be adapted to various community approaches. The ability to qualitatively analyze data that had been collected monthly, for 24 months, from nine communities concurrently implementing the same intervention framework with community variations, provided an opportunity to robustly explore CE implementation strategies and barriers in the CHL intervention communities. These strategies involved building capacity in CHL communities, working with diverse groups in communities, leveraging outside resources, establishing trusting relationships, and providing opportunities for communities to be civically engaged. The nuances of interactions of CE building block strategies as they were applied to the CHL intervention helped to understand what is required to implement CE activities and operationalize the CE MAM.

The barriers identified in the CHL intervention were similar to those found by Richards et al, (2014) in their analysis of a community-based childhood obesity prevention intervention. Understanding the barriers inherent in community work and finding ways to minimize their impact on intervention implementation not only allows for better outcomes, but may be applicable to other community organizing endeavors. An understanding of how to operationalize the CE MAM was exemplified by examining the strategies used and the barriers encountered by the CHL intervention communities.

All three of the studies in this dissertation (reported in Chapters 4, 5, and 6) found the CE MAM to be "*a clearly articulated conceptual model showing the relationships among major intervention components or a program planning model to guide the choice of the intervention components*" (National Heart, Lung, and Blood Institute, 2015 https://www.nhlbi.nih.gov/research/reports/intervention-recs-for-high-risk-populations). The cross-case analysis of the CHL intervention findings demonstrated the operational method and usefulness of the CE MAM as a way to meet the NHLBI workgroup recommendations for implementing multilevel interventions.

Recommendations for the Application of the CE MAM

Based on the findings from this dissertation research, the following are recommended for the operationalization of the CE MAM:

(1) *Integrate Social Ecological frameworks:* CE interventions are inherently multilevel and contain multiple components as indicated in Chapters 2, 4, 5, and 6. The literature review conducted prior to this dissertation found community-based CE interventions addressed multiple levels of the social ecological model (Butel & Braun, 2016) and Chapters 4, 5, and 6 demonstrated how multilevel interventions could be applied to the CE MAM.

The main model used by multilevel interventions is the Social Ecological Model (SEM) (McLeroy, Bibeau, Steckler, & Glanz, 1988) with activities addressing the intrapersonal, interpersonal, organizations, community, and policy levels. The SEM has often informed interventions, however; "how" it has been applied and practiced in research is poorly documented (Glanz & Bishop, 2010). There has been a call to "design multilevel programs using systems and social/ecological models that attend to "connectedness" and integration across program components and levels" (Glasgow & Emmons, 2007 p. 427). Lessons learned from multilevel intervention research suggest a need for explaining interactions between the levels both theoretically and practically (Clauser, 2012). Based on the results of this dissertation, interventions structured on social ecological models could use the CE MAM framework to: understand the connections between the multiple levels; establish a process to operationalize intervention plans; and track intervention progress.

(2) Allow for sufficient time for intervention implementation: Complex interventions, such as the CHL intervention involve dynamic communities, work with bureaucratic organizations, and include prolonged processes to implement certain activities such as environmental and policy changes. The CHL intervention took over 14 months to develop and included a community engagement process to identify intervention priorities (Fialkowski et al, 2013), a review of the literature (Nigg et al, 2016), a merge of community findings and the literature, and finally a written intervention formulation (Braun et al, 2014). Additional time was spent by the CHL intervention workgroup to identify ways to implement the activities in the various communities. Despite this extended planning process, the community implementer network (Chapter 5) took at least six-months to develop. Program, procurement, and organizational delays (Chapter 6) suggest that sufficient time is needed to navigate bureaucratic processes and procedures. Additionally, the surge in civic engagement at time interval three (12-18 months into the intervention) in the high dose group (Chapter 4) suggests that the implementation of policy and community change requires adequate time. The results of this dissertation suggest CE interventions take 18 months to gain sufficient traction to make changes, and therefore 2-year interventions may not be long enough to see community-level changes.

(3) *Utilize a combination of CE building block strategies*: There is a synergism between the CE building blocks that lead to implementation of activities. Chapter 4 identified an interactive relationship between activities that created strong connections (social bonding), reached out to diverse groups in the community (social bridging), and built capacity (empowerment). In describing capacity-building interventions, Dominguez and Alford (2012) stated that social capital (social bonding, social bridging, and social leveraging) are the basis for empowerment and community capacity development.

Examination of the network patterns between the CE building blocks in Chapter 5 realized connections between all CE building blocks occurred earlier in the high-dose communities, indicating that multiple CE building blocks were used to implement activities. This is supported by the CE literature review by Butel and Braun (2016), where CE interventions that addressed all CE building blocks realized better

outcomes. The findings in Chapter 6 showed the strategies used to implement the activities were a mix of all CE building block related strategies. For example, to implement the activity to train role models, multiple CE building blocks strategies were used. Jurisdiction-level CHL staff asked community members to identify potential role models (social bridging strategy), contacted the identified role models and sought their buy-in (social bonding), and brought in outside expertize to conduct the training (social leveraging) before conducting the skills development (empowerment) training. The role models then stimulated community action (civic engagement) in their communities. The results of this dissertation indicate that employing a combination of CE building block strategies to implement activities that build on each other to affect community change has the potential to enhance outcomes.

(4) *Establish a backbone system*: Coordinating multilevel interventions is a complex and daunting task (Glanz & Bishop, 2010). The community-level backbone that developed between large organizations, community groups, and schools was cultivated by building capacity and social capital in the CHL communities and was key to intervention implementation. This is supported by the literature. Slater et al (2005) found that the lack of local support, leadership, or resources can create significant challenges in implementing complex interventions. The implementation of complex interventions that address health disparities, in a comprehensive manner, requires building collaborative capacity to take collective action (Kendall et al, 2012). The central role of social leveraging and large organizations in Chapter 5, as well as the social leveraging and empowerment strategies identified in Chapter 6 may have been influenced by the positive impact of the CHL coordinating center and the Land Grant Universities.

(5) *Consider minimal intervention dose*: Cheadle et al (2012a) applied a population dose model to Kaiser Permanente's Community Health Initiative to increase physical activity in middle-school students. Strategies were coded as having "low", "medium", or "high" effect strength, and the investigators found that communities with a "high dose" had more positive behavioral outcomes (Cheadle et al, 2012a). Building on Cheadle's work the CHL intervention leads developed an intervention dose formula

(Butel et al, 2016). Applying this formula to CE, Chapter 4 identified a minimum total CE intervention dose of 200 to affect change in screen time in the CHL intervention. The nuances and interactions between the CE building blocks creates challenges for intervention planning and dose determination. However, results of Chapter 4 point to a process to assist in dose determination. The proportion of activities that addressed social bonding, social bridging, and empowerment were similar, approximately 20 percent for each. Social leveraging consisted of about 30 percent of implemented activities, with civic engagement activities accounting for around 10 percent. When considering minimal intervention dose, special consideration should be given to civic engagement activities. Implementation of civic engagement activities are related to increased CE (Collins et al, 2014). However, civic engagement has been shown to be the result of increased social capital and empowerment activities (Collins et al, 2014; Dominguez & Alford, 2012).

The strategies to implement CE building block activities are intertwined. In Chapter 6, when looking at the strategies CHL used to implement the activities in the various activity groups (cross-cutting functions), empowerment strategies appeared to work hand-in-hand with social bridging strategies. Empowerment strategies, in particular the basic themes of skills development and awareness, were important in building capacity. Designing and planning a CE intervention with the proportions identified in the CHL intervention and consideration of the dose of civic engagement activities may be a starting point to estimate minimal intervention dose.

(6) *Build relationships with community groups*: The implementation of complex interventions that address health disparities, in a comprehensive manner, requires building collaborative capacity to take collective action (Kendall et al, 2012). To meet these requirements, relationships need to be established. The network maps in Chapter 5 showed how the role of community implementers increased over time, and the social bridging strategies identified in Chapter 6 articulated the need to build relationships in communities to implement activities. Community messaging, information gathering, and community input strategies indicate the effort to build relationships in the CHL communities. The earlier development of social networks

and the greater assistance of community groups, local schools, and role models in the high-dose communities points to the development of community-based relationships. Other efforts to build relationships in the community were seen through building capacity in communities. Skills development, along with creating awareness and leadership development, were strategies frequently used in the CHL intervention. The results of developing relationships appeared to be key in effecting positive change (as seen through decrease in screen time) in high-dose communities. The high-dose group had a variety of community implementers for civic engagement activities compared to the preponderancy of large organizations assisting in the low dose communities. Supporting this need to build relationships, the U.S. Department of Health and Human Services (2016) recommends a "place-based" organizing framework involving collaboration of community-based partners to implement complex multilevel community interventions. To implement CE interventions, building relationships with community-based groups would be recommended.

(7) *Understand barriers' influence on implementation*: Barriers to the implementation of community-level interventions are to be expected, as communities are dynamic. Richards et al (2014) found that activities that target the organizational, community, and policy levels of the social ecological model encountered more barriers than those targeting individuals or interpersonal relationships. Similar barriers found in the Richards et al (2014) study (i.e. lack of human and financial resources, political issues, and competing priorities) were found in the barriers identified in the CHL intervention. Some barriers slow the implementation of activities (i.e. procurement delays and modifications) while others (i.e. complexity and resources) may cause implementation failure. To better understand barriers' influence on implementation a flow chart was developed in Chapter 6 and is repeated below (Figure 7.1) as a guide to assist in the implementation of CE interventions using the CE MAM. To operationalize the CE MAM, it is recommended to acknowledge barriers that are inherent in complex interventions and understand their influence on activity implementation. Building relationships with key partners helps overcome barriers by cultivating trust and understanding of the culture of the community to identify resistance to change (Richards et al, 2014). Additionally, this study found that

barriers to implementation can be overcome provided the community has "ownership" and "buy-in" and feel that the activities positively impact their community.

(8) *Establish a systematic process to collect intervention implementation data:* The data used for this dissertation was collected systematically using a intervention monthly report template. Information on what was done from specific community members that were part of a community-based group, a role model, and/or part of a local school was gathered and combined with activity information from CHL staff. The team then compiled the information and completed monthly process reports that were submitted to the coordinating center. The CHL coordinating center evaluated the reports to assist the jurisdictions in identify points of leverage and addressing challenges (Butel et al, 2015). This system points to a way to collect data and establish communications to assist in the implementation of CE interventions being conducted in multiple locations.

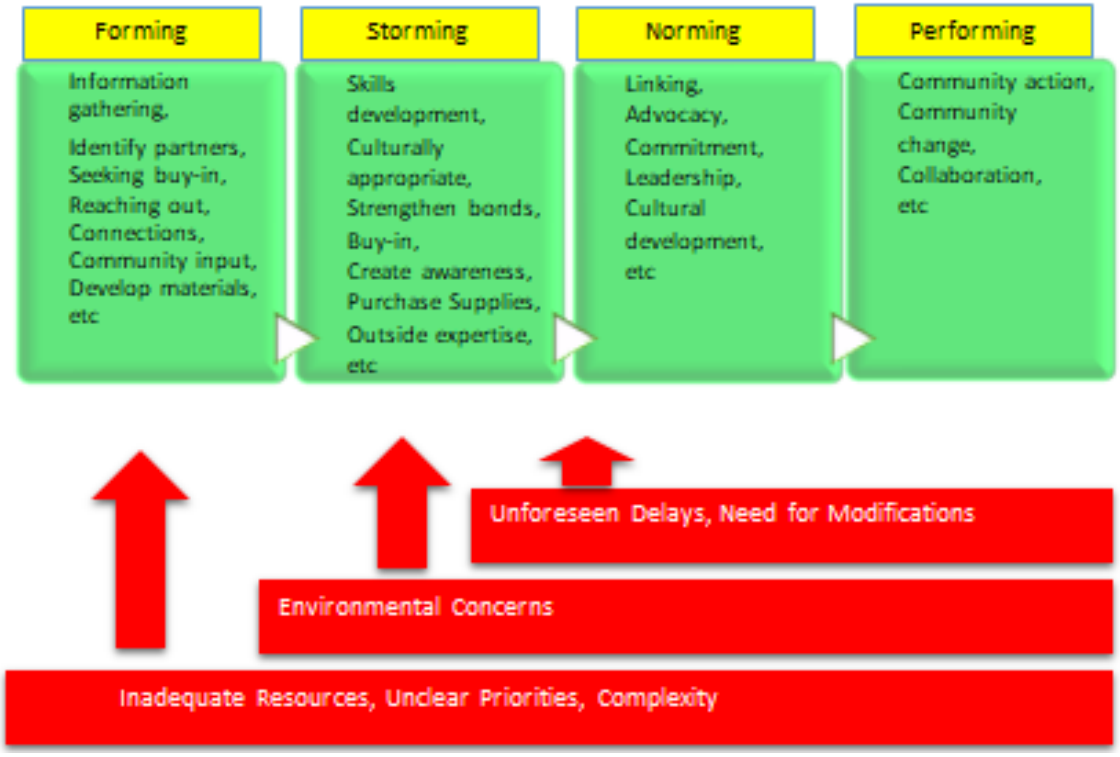


Figure 7. 1. ***Barrier Effects on Implementation Progression***

Future Research

Results from the dissertation studies indicated the need for additional research to inform the intervention processes in these areas:

(1) Conduct descriptive research on attributes of community implementers and intervention staff. Some potential reasons for the differences seen between the CHL communities could be due to staff and community attributes. Attributes, such as perseverance, work-arounds, flexibility, ability to capitalize on events, and connections to community would further assist CE intervention developers and operationalization of the CE MAM.

(2) Conduct research on integration of evidence-based programs into the CE MAM. Development of a mapping process between activities in evidence-based programs to the CE building blocks would provide a guide for integration into the CE MAM.

(3) Establish minimum CE dose for interventions. This would include a process for calculating dose and systematically applying it to various interventions. Analysis of dose and effect of interventions would then be used to determine a suggested CE minimum dose.

(4) Establish a standardized CE scale that could be used for a variety of outcomes. This would go a long way in standardizing the effects of intervention on CE. To have wide-use appeal and consistency, research is needed to determine if the adoption of a current valid CE scale, such as Sampson's Neighborhood Collective Efficacy scale (Sampson, 1997) would be applicable to a variety of outcomes.

(5) Apply the CE MAM to a CE intervention. Using the CE MAM to guide the development of a community-based, multilevel intervention would test the ability to operationalize the model in real time. Incorporation of the recommendations for application of the CE MAM would further validate this dissertation's results.

(6) Compare CE MAM based interventions to other models. This would guide the field in determining the most efficacious approach.

Conclusions

To achieve and sustain changes that improve community health outcomes, multilevel interventions are suggested (Glanz & Bishop, 2010). This requires collaboration and community capacity-building, which can be difficult in underserved communities (Sandel, 2016).

Additionally, the process to implement multilevel community interventions lacks an actionable process (Glanz & Bishop, 2010). CE shows promise to improve health outcomes (Butel & Braun, 2016), and the CE MAM was created to provide a process to guide the implementation of multilevel interventions.

The purpose of this dissertation was to operationalize the CE MAM as a process to improve health outcomes by identification and verification of CE building block activities in the multilevel multisite CHL intervention. Additionally, this dissertation aimed to examine community relationships needed to implement the CE MAM, and to identify strategies and barriers to implementation of the CE MAM.

CE building block activities were identified using cross-case analysis of the multilevel, multisite CHL intervention. Analysis of the secondary data verified the necessity of implementing activities that address all five CE building blocks in multilevel community interventions. A minimum CE intervention dose was suggested to effect community health outcomes.

To achieve the suggested CE intervention dose, assistance from community partners to implement activities was required and took at least one year to develop actionable relationships. Community-based groups and local schools were identified as key partners with large organizations providing implementation support and community capacity development. Social network analysis suggested the development of a community-based network with multiple partners to stimulate community action and positive change.

Community intervention process reports submitted by the CHL intervention communities served to identify implementation strategies and barriers. Strategies were organized by CE building blocks. Strategies suggested the use of multiple strategies from various CE building blocks to implement activities. High use of empowerment and social bridging strategies suggested the need to build community capacity and reach out to diverse groups within the community. Barrier findings suggested need to build in time for delays and modifications, work to reduce complexity, and to establish priorities when planning interventions.

In summary, with data from the CHL intervention, the information from this dissertation will be directly applicable to further CE research, as well as, operationalizing the CE MAM to provide a process to guide multilevel and CE community interventions.

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